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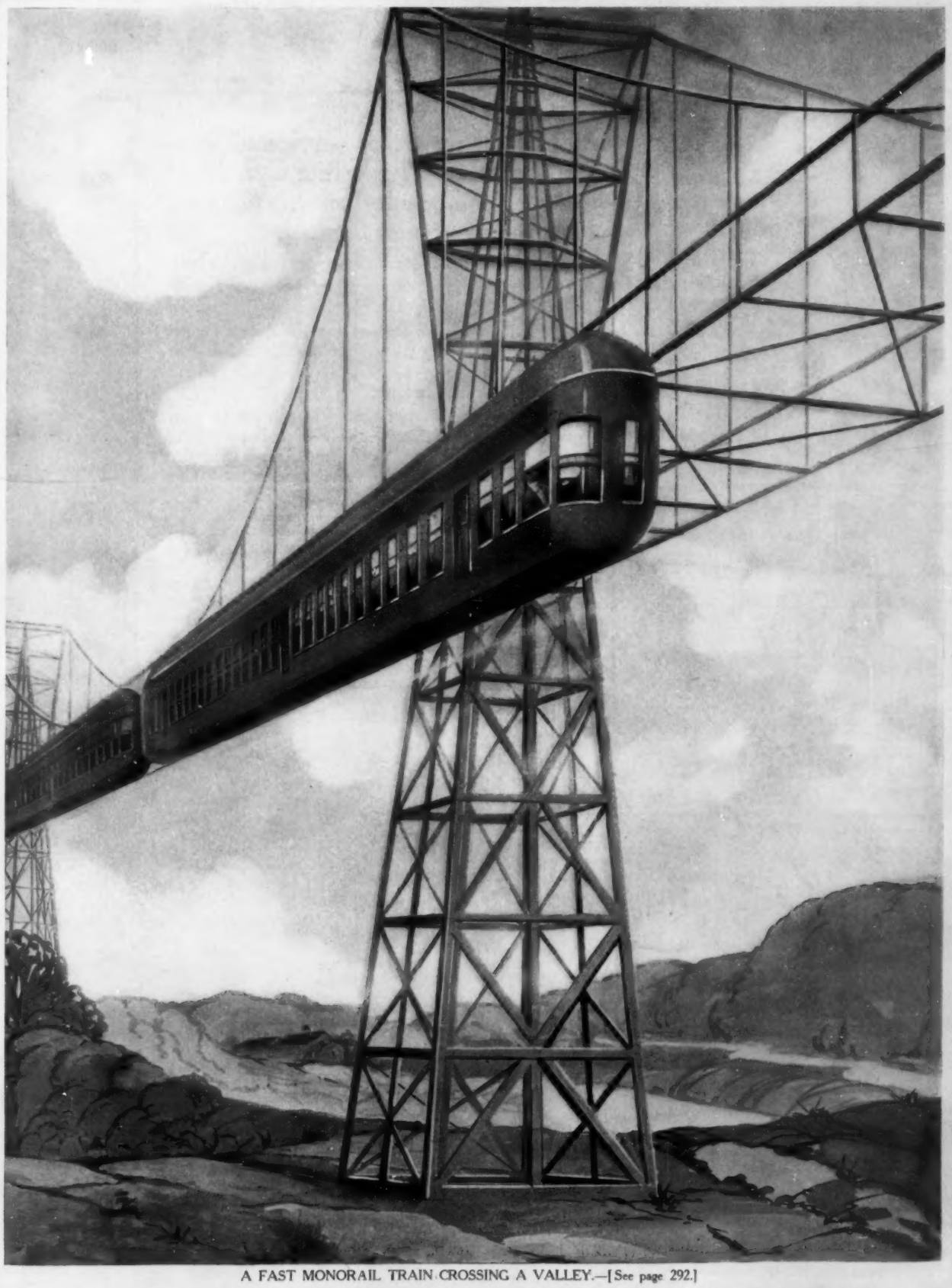

A FAST MONORAIL TRAIN CROSSING A VALLEY.—[See page 292.]

Vol. CXII. No. 13
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Rescue Company No. 1 of the New York Fire Department

THERE is nothing a fireman dreads so much as a smoky fire, and when that smoke contains choking fumes and poisonous gases his task is hazardous in the extreme. Nevertheless he must penetrate that smoke to its source, regardless of personal danger. Time and time again have the firemen of New York city risked their lives in fires of this kind, bravely rushing into veritable death traps, struggling until overcome, then being dragged out in the nick of time by their companions; and sometimes they have not been dragged out in time.

Although such conditions have existed for a long time, and the work of mine rescue squads has pointed out the value of smoke helmets in just such conditions, it was not until after the subway fire last January that any definite action was taken. At that time, it will be recalled, hundreds of passengers stalled in the subway were overcome by the fumes of burning insulation, and the firemen had no end of difficulty in dragging them out. The SCIENTIFIC AMERICAN then pointed out the urgency of having a rescue squad of firemen equipped with smoke helmets. Immediately after the fire, with commendable promptness, such a company was organized.

Tests were made of six or seven varieties of smoke helmets in order to determine the best for firemen's use. Finally the one shown in the accompanying illustrations was adopted with a slight modification at a point which was thought to show a slight weakness, and ten helmets of this type were bought. The manufacturers claimed that this helmet with its oxygen tank and regenerator would keep a man supplied with fresh oxygen at the rate of two liters (about two quarts) per minute for an hour. At the end of that time a gage, known as the "finimeter," would register zero, but there would be still enough oxygen in the tank to keep a man supplied at the same rate for twenty minutes more. In order to make sure of this, Capt. John J. McElligott, in charge of the rescue company, decided to try out the helmet under extreme conditions. At the Firemen's College there is a concrete room, twenty feet square, where sprinklers are tested. Into this room a quantity of smoke-making fuel was put, consisting of excelsior, straw, oakum, rubbish of all kinds, and sulphur. This was set afire and it produced dense volumes of smoke and intense heat. Into this inferno Capt. McElligott went equipped with his smoke helmet, and the door was closed behind him. The firemen found it difficult to close the door at first because of the outflow produced by expansion of the air in the room. The helmet was equipped with a telephone, by which Capt. McElligott could communicate with the outside. He had with him a thermometer registering up to 500 degrees, and he found that the temperature rose quickly to 280 deg. Fahr. Despite this intense heat, he remained in the room watching the index pointer of the finimeter gradually swing down to zero, when his watch showed him that he had been in an hour, and then he remained fifteen minutes more—seventy-five minutes altogether in a temperature which, for at least three quarters of an hour, was up to 280 deg. Fahr. At the end of that time he emerged thoroughly exhausted, streaming perspiration, with the sweat slushing in his shoes at every step. His clothes were rotted by the action of the fumes, and his hands were so blackened that it was impossible to wash them white again. The discoloration did not wear off for weeks.

It is astonishing what an intense heat one is able to stand in dry air. Water at a temperature of 150 degrees would scald a person. In a Turkish bath the temperature may go up to 200 degrees. But 80 degrees above that is decidedly uncomfortable, to say the least, and it is really remarkable that anyone should have been able to stand it for an hour and a quarter. Capt. McElligott states that it was very distressing, but that he experienced no scalding effect except at one time when a drop of water, which evidently had condensed upon the ceiling, splashed down on the leather flap of his helmet and burned right through to his neck.

The air regenerating apparatus.

This kind of helmet apparatus has been described in the SCIENTIFIC AMERICAN before, but a brief explanation of its operation may not be amiss. From the helmet there are two tubes leading down to a pair of "breathing bags" that rest on the breast of the wearer. One of these bags takes the surplus inspiratory air and the other the surplus expiratory air. The air that is exhaled passes from the breathing bag to the back of the wearer, where it is forced through a regenerator consisting of a receptacle containing caustic potash. The caustic potash removes the carbon dioxide. The regenerator is shown at the left in the rear view of the apparatus. At the right is the tank in which oxygen is kept at a pressure of about 1,800 pounds per square inch. This passes through a reducing valve so that it will flow out at the rate of two liters per minute, and passing through an injector serves to force the exhaled air through the regenerator. As some heat is produced in the regenerator, the air mixed with fresh oxygen passes through a cooler before making its way to the inspiratory breathing bag. Thence it is inhaled through the tube shown at the left hand in the front view of the helmets. In order to make an effective seal of the helmet, it is provided with a soft rubber tube which is inflated to fit snugly around the face, and this is pumped up by means of the small bulb pump which may be seen hanging from the face plate of the helmet. On the opposite side of the face plate is a small projection, which is the handle of a sponge mop with which the fireman may wipe the perspiration out of his eyes or brush away any irritation. This is a feature that is very much appreciated. Divers who have no such means of relieving itching or irritations of the face, frequently suffer untold agony.

For nearly two months eight men besides Capt. McElligott and his lieutenant have been practising with this apparatus and also with pulmotors and a Blaugas-oxygen torch, and on March 8th they were established as Rescue Company No. 1. They have a motorcar fitted with the Blaugas torch apparatus, two pulmotors, stretchers, smoke helmets, and additional cylinders of oxygen for the pulmotors and the helmets, besides the customary life-gun, fire-extinguishers, axes, etc. They respond to every two-alarm fire south of Fifty-ninth Street and to three-alarm fires as far as 125th Street. Already they have shown themselves invaluable. At a recent fire in a building extending from Greene to Mercer streets, the fire was at one end of the building and the entrance at the other. This meant that the firemen would have to grope through two hundred feet of black smoke before reaching the fire. Ordinarily this would have meant the suffocation of many of the men, but the helmeted men went to the front without the slightest difficulty and located the blaze.

Members of the first rescue company of the New York Fire Department.

As yet the torch has not been put to any service, but it is provided for occasions where armored doors are encountered which resist the battering of axes. With the torch the locks can be cut out with practically no delay. In a test of this apparatus a bar of steel four inches square, in cross-section, was cut through in 63 seconds. The apparatus carried by the company has a capacity of fifty-six 1-inch cuts. It will be recalled that when the Equitable Building burned down a number of men were trapped in the basement behind windows guarded by thick iron bars. The firemen exerted almost superhuman efforts in endeavoring to cut through those bars. Had the Rescue Company been in existence then, the bars could have been burned through in a couple of minutes and the men easily saved.

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The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp* the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

The purpose of this journal is to record accurately, simply, and interestingly, the world's progress in scientific knowledge and industrial achievement.

A Fair Field and No Favor

THE failure of the Shipping Bill has served the purpose of clearing the atmosphere of some of the fog which has covered the whole question of the American merchant marine, and to that extent the attempt to pass this bill, involving as it did a lengthy and very thorough discussion of the question in all its bearings, has been profitable and in many ways helpful. The policy of the straight subsidy has been subjected in previous years to a similar thorough thrashing out, both inside of Congress and outside; its fallacies have been exposed; the whole country has been given an opportunity to express its wishes in the matter; and it is now certain that the question of subsidy is dead for all time. Another proposed panacea, from which much has been expected, namely, the imposition of preferential duties, has been rejected. The restriction upon the purchase and operation under our flag of foreign-built ships has been removed; and while some advantage has resulted from this measure, the benefit has proved to be so limited as to leave the problem pretty much where it was. Hence, it must be admitted that the endless discussion and the attempted legislation for the merchant marine have served a good purpose in so far as they have cleared the air and brought both Congress and the nation a measurable step nearer to the true solution of the problem.

The causes which render the construction and operation of the American-built ships unprofitable are twofold. First, it costs more to build a ship in our yards than it does in foreign yards, and secondly, because of certain burdensome navigation laws, it costs a great deal more to operate them.

The first difficulty should be met by doing everything possible in the way of legitimate legislation to remove the handicap under which our shipbuilders labor; and to this end it would be advisable to permit the importation free of duty of all materials which enter into the construction of ships built for the American merchant marine. A few years ago, and for aught we know, to-day, the plate mills of this country were selling ship plates at a lower cost in Great Britain than they could be bought by our own American yards. It would be a far-sighted policy on the part of our steel mills, if, in the endeavor to encourage American shipbuilding, they made it a point to lay down ship plates in American yards, at least at the same price as they are delivered to foreign shipbuilders. If this were done, and all the materials that enter into the construction of a ship were permitted to enter this country free of duty, the materials cost would be considerably lowered and our shipbuilding yards, in spite of their heavy labor costs, would, by their excellent system of management and the super-excellence of their plant, be in a position to build, if not as cheaply, at least very closely to the price at which tonnage is turned out in foreign yards.

The principal burden under which our mercantile marine labors, however, is the much greater cost of operation. This is due to certain antiquated and very burdensome laws with respect to the employment of seamen, their accommodations, food, and the various regulations governing their employment. As long as this burden exists, our merchant marine will be heavily handicapped in competition with the deep-sea shipping of the world. If Congress, instead of wasting its time in trying to pass laws which like the defunct Shipping Bill are opposed to the most elementary economic principles, would set itself seriously to consider a revision of our navigation laws and the removal of the burden under which our deep-sea trade is carried on, we believe that private capital would be encouraged to enter generously upon the task of building up a great merchant marine. Before many years we should be in a position to carry our own goods in our own bottoms and retain the $300,000,000 annually which is now paid to foreign shipowners.

Legislation of this character would be well directed. It would receive the endorsement not only of the shipping interests but of the vast majority of the people of the country. There is not a practical shipping man in the United States to-day who does not believe that, if thereby Congress gave our merchant marine an opportunity to demonstrate what it could do in a fair field with no favor, it would ultimately regain the proud position which it held in the middle decades of the last century.

The Chemist as a "Trust Buster"

IN the last report of the Bureau of Mines, Director Holmes made a stirring appeal for Government aid in behalf of industrial research. He pointed out that the Department of Agriculture spent about as much for printing and binding alone as the Bureau of Mines for research, and this despite the fact that untold millions could be added to the country's wealth if the Government scientists were given the opportunity. Although he did not say so, he probably despaired of interesting our populistic congressmen in his plans, apparently because farmers, having votes, may ask Congress for anything and obtain it, and because mines are owned by capitalists who are not in high favor just now. Being a mere scientist he did not understand how these problems should be attacked. Instead of talking economics and conservation he should have talked "trusts" and "oppression."

The Secretary of the Interior understands these things better. A scientific man would never dream of converting a chemical discovery into political capital. Now that the Secretary has shown how the Rittman process of increasing the yield of gasoline may become a means of thwarting the deviltry of Standard Oil, he will know how a chemical formula may be miraculously transformed into a battle cry of freedom from trust control, how politics and science may be united, and how the millions we need for research may be obtained.

Back of Secretary Lane's public announcement lurks the spirit of antagonism against large corporations that has animated the present Administration. We had thought that the fangs of the Standard Oil had been drawn long ago and that it had been reduced to thirty-three harmless parts. We had thought that the only marked development in petroleum refining of recent years—the Burton process of cracking—was a development of the Standard Oil Company of Indiana alone. In the face of the well-known "state of the art," as patent lawyers term it, Secretary Lane makes the absurd statement that "for some time the Standard Oil Company through the great amount of money at its command, through its employment of expert chemists, and through its extensive organization, has had a big advantage over the independents in the production of gasoline, this company having a patented process that obtains for it as much as three times the amount of gasoline from a given quantity of petroleum as the independents now obtain." This, we presume, is a veiled reference to the Burton process, which, we repeat, was developed by the Standard Oil Company of Indiana alone. "There are two or three other large corporations," continues Secretary Lane, "that have an efficient process for the manufacture of gasoline, but the independents as a whole have never been able to approach the results obtained by the Standard Oil Company. Now the Federal Government, through the efforts of Dr. Rittman, proposes to make free, for the use of all of the people of this country who wish it, a process that is confidently expected to increase their yields of gasoline from crude petroleum fully 200 per cent and perhaps more."

The publicity methods which have been adopted by Secretary Lane must be offensive to every real scientific man. Dr. Rittman's process is still in the laboratory stage. It is contrary to the unwritten code of scientific ethics to exploit an undeveloped invention in this cheap promoter fashion. When it is considered that many thousands of dollars must still be expended to ascertain whether or not laboratory success can be duplicated on a factory basis and that much ingenuity must be exercised in devising pressure retorts which will work day in and day out with the regularity demanded by a commercial enterprise, the Secretary's announcement must be considered as reckless. There are oil refiners enough in the United States of America who would gladly have conducted experiments on a sufficiently large scale to ascertain just what we may expect of Dr. Rittman's investigations; but until those experiments had been made it was wrong to mislead the public by rushing into print.

If the Secretary's statement had been more guarded and accurate, even its premature publication might have been overlooked. As it stands, it presents an absurd picture of the control supposedly exercised by the Standard Oil Company on the development of the petroleum industry on its scientific side and of the miracles that are to be achieved in building up a coal tar chemical industry comparable with that of Germany. Let anyone read the paper by Brooks, Bacon, Padgett, and Humphrey in the March number of the *Journal of Industrial and Engineering Chemistry* and he will learn what the state of the petroleum refining art really is and how much has been contributed to our knowledge of "cracking" distillates by English, French, German, and Russian chemists. Anyone can take the old Dewar and Redwood process, upon which even the Burton is only an improvement, and work it with success.

Chemists will be even more amused by Secretary Lane's conception of a coal tar dye industry founded on the basis of Dr. Rittman's undeveloped laboratory discoveries. Anyone who has read Dr. Bernhard C. Hesse's analysis of the coal tar dye industry of Germany, made for the General Chemical Company, must be convinced that even if the Rittman process be carried to the most brilliant commercial success, we must have something more than cheap raw material with which to make synthetic drugs and dyes. There must be co-operation between the dye user and the dye maker. The manufacture of coal tar chemicals is an economic rather than a technical problem. Hundreds of intermediate products must be handled in a way that is distinctly forbidden by our anti-trust laws. We have a small coal tar chemical industry now, but it can never grow to the proportions of the German trust-controlled industry merely because the Rittman process may give us cheap benzol. If there is any doubt about this, consider the following from the "Recommendations of the New York Section of the American Chemical Society on the Enlargement of the Coal Tar Chemical Industry in the United States":

> Benzol, toluol and the like are produced in sufficient amount in present installations of by-product coke-ovens to provide all of the things that would be needed for a coal-tar chemical industry of a magnitude sufficient to supply the United States market; the separation of these materials from the gas that carries them is dependent upon the market and the demand therefor. There is no inherent defect in our coke-industry with regard to the actual making of these things; the only question involved is whether it be more profitable to burn the benzol, toluol and the like contained in the gas as a fuel than to separate them from the gas and from each other for purposes of sale. Ample supply can be provided before any plant that could use benzol and the like for dyestuff making could be erected in the United States, and thereafter the supply of these materials can readily be kept up to any requirement.

After that one has a feeling that Germany may continue to sing: "Lieb Vaterland magst ruhig sein."

Scientific Research in the Public Health Service

ONE result of the national health insurance law recently put in operation in Great Britain is that the British government is now making a liberal annual expenditure for medical research. The law provides that a definite portion of the funds contributed by Parliament to the insurance scheme shall be spent in research, and this amounted in 1914 to the respectable sum of £56,000.

It is an interesting coincidence that the United States Government has also quite recently placed its work in medical research on a firm footing by materially enlarging the scope and resources of the Public Health Service. A law enacted August 14th, 1912, contained broad authorization for investigations of "the diseases of man and conditions influencing the propagation and spread thereof, including sanitation and sewage and the pollution, either directly or indirectly, of the navigable streams and lakes of the United States," and a year later an appropriation of $200,000 was made for field investigations under this authorization. Additional funds were authorized for enlarging the work of the Hygienic Laboratory and for other incidental purposes connected with research.

According to the annual report of the service recently issued, the last fiscal year marks the beginning of a new epoch in the development of medical research by the Government. The summary of the work done in this direction by the service runs to 117 octavo pages, and is a remarkable record of beneficent activity.

Among the diseases of man investigated in the Government laboratories and hospitals and in the field were beriberi, diphtheria, endemic goitre, hookworm disease, leprosy, typhoid fever, malaria, pellagra, trachoma, tuberculosis, typhus fever, and various occupational diseases. These studies also entailed the investigation of sanitary conditions; systematic studies were made of rural sanitation, school hygiene, industrial hygiene, and health organization and administration. Lastly, investigations were made on the pollution of rivers and coastal waters, the disposal of sewage, and the treatment of industrial wastes. These undertakings entailed a large increase in the research staff of the service.

Notes on the War

Aftermath of the North Sea Fight.—Probably, when the history of the North Sea fight between battle-cruisers is written, it will be found that the 29-knot "Lion," "Tiger" and "Princess Royal" were opposed to the "Doerflinger," "Seydlitz" and "Moltke" of about the same speed, and that the "Indomitable" and "New Zealand" of 26½ and 27 knots were outdistanced. If so, after the disablement of the "Lion" and her withdrawal, the three German battle-cruisers possessed a heavy preponderance of armor-piercing guns over the "Tiger" and "Princess Royal," opposing as they did twenty-eight 11- and 12-inch guns to sixteen 13.5-inch. As we showed in a recent article, the German guns outranged the British, and, in view of their heavier gun fire, the fact that the Germans even then continued their flight suggests that the Admiralty had given orders to avoid an engagement and save the ships for the big fleet engagement, should it ever come off.

Two Hundred Miles of Trenches on 12-mile Front.—A correspondent of the New York *Times*, describing a trip along the line of the French, British and Belgian forces, speaks of visiting a stretch of fighting front 12 miles in length, on which the line was so irregular and so intricate, that the total length of the successive trenches with their zigzag approaches, etc., was 200 miles. Although this seems to be an exaggerated estimate, it is by no means impossible under the conditions of French warfare as being now carried out on the eastern front. Where the advance is made by yards at a time, and captured trenches are added to those of the successful advance, it is quite possible that from the foremost line facing the enemy, back to the rearmost trenches of the attacking force, the total length, if the zigzag approaches are taken into account, might well reach the high figure quoted. This will be understood if a study has been made of the modern system of entrenchment, as shown in our issues of October 3d and December 5th, 1914.

A Demand for 16-inch Coast-defense Guns.—Before the "Queen Elizabeth" had done her surprising work in reducing the Dardanelles forts at 21,000 yards range, Brigadier-General E. N. Weaver, Chief of Coast Artillery, had recommended the construction of 16-inch 50-caliber guns for the new fortifications at the entrance to the Chesapeake Bay. Such a piece would be superior to the 15-inch naval guns on every point of comparison. The Elswick 15-inch naval gun fires a 1,925 pound shell with a muzzle velocity of 2,500 feet per second and a muzzle energy of 83,425 foot tons. A coast defense 50-caliber 16-inch piece, firing a 2,500 pound shell with equal velocity, would have a muzzle energy of well over 100,000 foot tons; moreover, because of the high degree of elevation which could be given, it would greatly outrange the 15-inch gun. In view of the extraordinary increase in fighting ranges developed during the war, it will be good policy to mount some 16-inch guns at all our existing defenses, and particularly at Panama, and in the Philippines.

Obsolescent Battleships to the Fore.—Very interesting is the fact that the bulk of the battleships which are engaged in reducing the forts of the Dardanelles are ships whose term of usefulness was supposed to be near its end. That estimate, however, was based upon their ability to stand the test of battle on the high seas, in which work, if matched against modern ships, they would be worse than useless. For the particular duty assigned them in the Dardanelles, namely, that of silencing the guns of small caliber and limited range after the heavier guns of from 9.4- to 14-inch caliber have been dismounted by such ships as the "Queen Elizabeth," the "Nelson" and the "Agamemnon," they are admirably suited. Their 10- and 12-inch shells carrying large charges of high explosives have proved to be terribly destructive in wrecking gun positions, blowing up magazines, etc. Their armor of from 12 to 16 inches in thickness and the possession of the heavy protective decks, which were given to ships from 15 to 20 years ago, enabled them to withstand the attack of 5- and 6-inch shells with comparative immunity.

Eight Russian Dreadnoughts Approaching Completion.—An important fact affecting the naval situation in the Baltic, of which little public mention has been made, is that the Russian fleet in those waters will shortly be augmented by the addition of eight new dreadnoughts of great size and power, which are nearing completion and will probably go into commission during the present year. Four of these ships, the "Sebastopol," "Petropavlovsk," "Poltava" and "Gangut," are dreadnoughts of 23,026 tons displacement, 23 knots speed, carrying each twelve 12-inch guns and sixteen 4.7-inch guns. They were launched between June and October, 1911, and work upon them having been accelerated, they should be in commission before many months have passed. The other four will be the largest battle-cruisers afloat. They are named the "Ismaha," "Kinburn," "Borodino" and "Navareno." The displacement of these ships is 32,200 tons, the speed 28 knots, and each of them will carry the enormous battery for a battle-cruiser of twelve 14-inch guns and twenty-one 5.1-inch guns.

Science

Vulcanological Studies in the West Indies.—Dr. E. O. Hovey has been sent by the American Museum of Natural History to the West Indies to continue the vulcanological investigations that he began in that region after the great eruption that destroyed St. Pierre. He expects to spend about three months in studying, especially, the Grande Soufrière of Guadeloupe, Mont Pelé, the Soufrière of St. Vincent, and the boiling lake of Dominica, collecting gases from the fumeroles, making temperature observations, and noting the changes that have occurred since his last visit.

Concentrated Cider and Cider Syrup.—These two new products of surplus and cull apples are described in the last annual report of the U. S. Bureau of Chemistry. In manufacturing the former the apple juice is frozen solid and the block of ice is crushed and placed in a centrifugal machine, which removes the concentrated cider, leaving the ice behind. The product, when diluted with water, has practically the flavor and qualities of the original apple juice. The concentrated cider ferments very slowly at refrigerator temperatures, but at room temperatures ferments in a few weeks. It is, of course, much cheaper to transport than ordinary cider. Cider syrup is made by clarifying and boiling down apple juice, and it is said to be of value for table use.

The Auto-irrigator.—This is a new instrument for measuring the water-attracting power of the soil, devised in connection with experiments by Prof. B. E. Livingston and Dr. L. A. Hawkins at Johns Hopkins University. It is essentially similar to Livingston's porous-cup atmometer, but the cup is buried in the soil instead of being exposed to the air. The experimenters have carried out a series of measurements upon potted plants irrigated automatically with this device. The rate of water-loss from the irrigator is found to be highest somewhat later in the day than the time of maximum transpiration from the plants. The rate of loss from the irrigator then falls slowly, reaching its minimum in the early morning.

Effects of Grass on Trees.—This subject was brought into prominence a few years ago by the researches of S. U. Pickering, of the Woburn Experimental Fruit Farm, in England. We have previously noted in these columns his observations concerning the very injurious influences of grass on orchard trees, apparently due to some toxic substance produced by the former. The question has now been taken up at another English research institution; viz., the Long Ashton station of the University of Bristol. Mr. Barker also finds that grass seriously impairs tree growth, but the effect is less marked in land which is grassed at the time the trees are planted and remains so than in land which is first cultivated and subsequently grasses. In other words, trees are able to acquire some degree of immunity from the toxic effect in question.

Salton Sea fell 42 inches during the year ending June, 1914, when the annual sample of its water was collected for analysis by the Carnegie Department of Botanical Research. The annual concentration of the water is about 18 per cent. During the year in question the total solids increased from 1,003 to 1,180 parts per 100,000. During 1914 the Carnegie botanists also made a collection of the algæ growing in Salton Sea, with a view to determining whether these plants are responsible for deposits of tufa, as has recently been suggested by Jones and Walcott. Similar investigations have been made in the Lake Lahontan basin, where remnants of algæ have been found in all the tufas except the thinolitic form. Laboratory experiments on the subject are in progress.

Biological Relations of Atmospheric Ionization.—Some recent studies of H. A. Spoehr indicate that sunlight and ultra-violet light, in addition to their direct physical and chemical influence on important plant processes, also affect these processes indirectly by affecting the air surrounding the plant. The effect is especially noticeable in the respiratory activity. Experiments were carried out in which the only variable factor to which plants were exposed was the air of day on the one hand and of night on the other. Air drawn from out-of-doors was freed from its carbon dioxide by means of coarse soda-lime, then drawn over the plants kept in the dark at constant conditions of temperature and humidity, and finally through a standard barium hydroxide solution in Meyer's tubes. The rate at which carbon dioxide was evolved by the plants was found to be regularly higher by day than by night. It was thought that this difference in respiratory activity might be due to variations in the chemical activity of the atmospheric oxygen as indicated by the values for atmospheric ionization, and this was tested by discharging the air by passing it between the poles of a series of electric batteries before it reached the plants. The differences in respiratory activity between day and night were found to be much reduced under these conditions. Without this deionizing process the course of the rate of carbon dioxide evolution showed a marked similarity with the values generally given for atmospheric ionization. Wheat seedlings were found most convenient for use in these experiments.

Astronomy

Rotation of Two Satellites of Saturn.—Observations made at the Lowell Observatory on the varying brightness of two satellites of Saturn, viz., Mimas and Enceladus, indicate that these bodies rotate on their axes in periods identical with those of their revolution around the primary; i. e., they behave like our own moon, and probably like satellites generally.

Copernicus Visible to the Naked Eye.—The Swiss astronomer J. Pidoux reports in *Astronomische Nachrichten* that he was recently able, from an elevated spot near Geneva where the air was particularly pure, to distinguish plainly with the naked eye the lunar crater Copernicus, when lying beyond the terminator, i. e., the summit of the crater was illuminated while the surrounding region was still in shadow.

The "Parsec."—This convenient unit, suggested by Prof. Turner, and used by the astronomer-royal, Sir F. Dyson, in a recent discourse at the Royal Institution, has not yet been defined in any dictionary. It is the distance at which a star's parallax is one second of arc, or 206,265 times the distance of the earth from the sun. If the sun were at a distance of 1 parsec it would still be one of the brightest stars in our sky, with a magnitude of 0.5. If distant 100 parsecs its magnitude would be 10.5. Most of the stars within the range of our telescopes are believed to be within a distance of 1,000 parsecs.

Remarkable Stellar Velocity.—Recent observations at the Mount Wilson Observatory on the star O. Arg. S. 14,320 indicate that it has a remarkably rapid motion in space. It is a star of the 9.2 magnitude, having a carefully determined parallax of +0.035 second and a proper motion of 3.76 seconds annually. Its radial motion, as determined approximately with the spectrograph, is +290 kilometers (180 miles) per second. This gives for its actual velocity in space 577 kilometers (358 miles) per second, which far exceeds even that of the famous star Groombridge 1830. The average velocity of a star in space has been estimated at about 21 miles per second.

The Magnetic Field of the Sun.—Prof. Hale and his assistants have continued their fruitful investigations of this subject, and during the past year 25 spectrum lines, all originating at comparatively low levels in the solar atmosphere, have been found to show the Zeeman effect, and hence the existence of the sun's general magnetic field. The elements represented by these lines are iron (10 lines), chromium (8), nickel (4), vanadium (2), unidentified (1). The displacements due to the general field appear to be confined to the lower levels of the solar atmosphere, in harmony with previous observations on this subject. The measurements show that the vertical intensity of the general field at the poles varies from a value of 55 gausses for the weakest lines to 10 gausses for the strongest lines yet found to show the effect. A preliminary attempt to detect the Stark effect due to electric fields in sunspots has not thus far yielded any positive results.

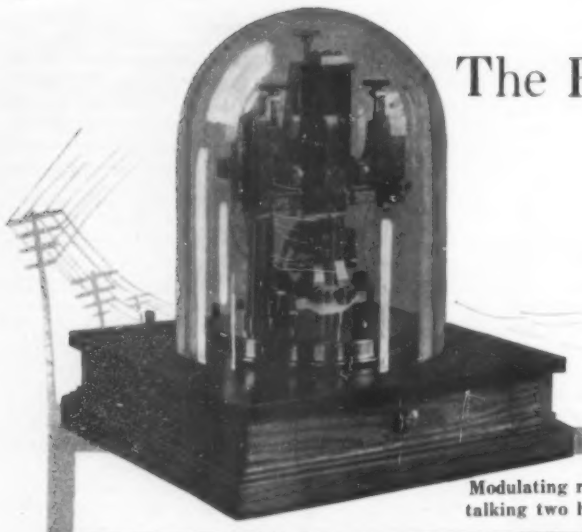
The Stars of Napoleon.—Camille Flammarion, writing in *L'Astronomie*, records with much gusto the fact that a German university once sought to curry favor with Napoleon by dedicating a group of stars to him. In 1807, when the French conqueror was at the summit of his power, the University of Leipzig issued a statement to the learned world setting forth the reasons which had led it "to consecrate to the glory of his majesty Napoleon the stars of the sword and the belt of Orion." These stars were not to constitute a new constellation, but an asterism in the constellation of Orion bearing the special name of "Stellae Napoleonis," just as a certain group of stars in Taurus bears the name of the Pleiades, and another the Hyades, etc. The academic announcement contained much fulsome praise of Napoleon, and pointed out the appropriateness of giving his name to a group of stars surmounting the constellation of Eridanus (the Po), the namesake of the terrestrial river near which Napoleon won his early victories.

Mounting for the 100-inch Telescope.—The last annual report of the Mount Wilson Observatory states that all the larger parts of the mounting for the 100-inch reflector (which will be much the largest telescope in the world) will probably be assembled at the Fore River shops, where they have been constructed, in time to permit shipment to Pasadena, *via* the Panama Canal, early this year. Meanwhile the smaller parts and accessories have been under construction at the observatory. The driving-clock, which is nearly completed, required more than half a ton of bronze castings and nearly 1½ tons of iron castings, in addition to the 2-ton driving weight. The circular steel building for this instrument is complete up to the rails which are to carry the dome. The latter has been built in Chicago and is about finished. The building and dome will probably be completed next summer so that the mounting may be set on the pier in the autumn. Meanwhile good progress has been made with the capital task of grinding and figuring the great mirror.

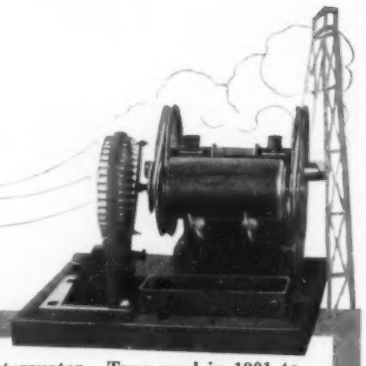
The Principles of Radio-Telephony

A Review of Recent Progress

By John L. Hogan, Jr.



Modulating relay. Used in 1907 tests for talking two hundred miles by radio.



Fessenden spark interrupter. Type used in 1901 to secure ten thousand sparks per second.

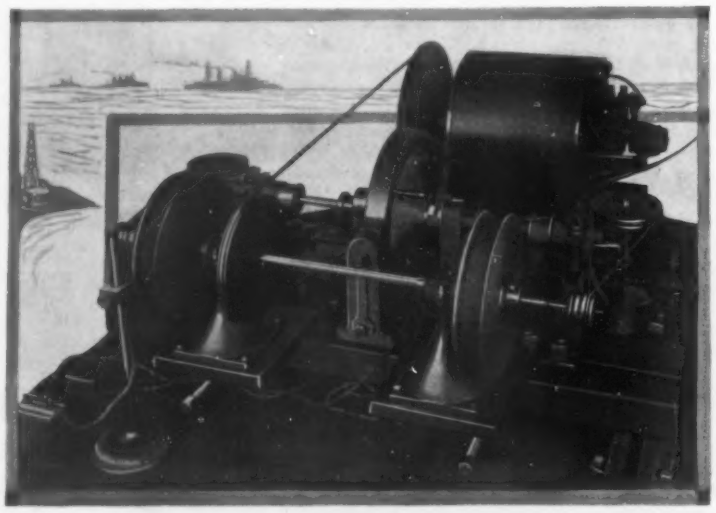
RADIO-TELEPHONY, or the transmission of vocal sounds by "wireless," bears much the same relation to wireless telegraphy as wire telephony does to ordinary line telegraphy. In each case of telegraphy the transmission of conventional signals representing letters of the alphabet is accomplished by sending forth electrical impulses in short and long groups, corresponding to dots and dashes, either into free space and guided only by the earth's surface (as in radio) or along a conducting wire. In each telephonic case there are sent out substantially continuous streams of small electric disturbances, in themselves too rapidly recurrent to produce individual effects of sound, which are guided either by a wire or by the earth's surface; these streams are modulated to conform to the conventional vocal sounds of language by some change in their characteristics.

In line telegraphy it is usual, by use of a "key," to start and stop a continuous flow of current at the beginning and end of each dot and dash, though some methods of Morse transmission use currents which are automatically interrupted or reversed at a rate high compared to that at which the key is manipulated. In these latter cases the telegraph key serves to turn on and off the stream of rapidly recurring impulses. The reception is effected, when direct current is used, by a sounder which clicks at the beginning and end of each impulse, or, in the alternating or pulsating current case, by a telephone which gives out a musical tone so long as the sending key is held down and the stream of impulses is permitted to flow. It is obvious that either method gives the receiving operator knowledge of the length of time the key is depressed, and therefore the ability to re-write dots and dashes (short or long signals) formed by the sender. It is equally clear that if pulsating or alternating current is used, with a telephone receiver, the variations in it must occur at a rate to which the receiver will respond to produce a musical tone, or say from 20 to 5,000 cycles of change in each sound, since otherwise the receiving operator could not determine the duration of each signal.

In radio-telegraphy it is customary to produce the required dots and dashes by starting and stopping groups of sparks, each of which emits a train of electromagnetic waves in the "ether," which waves travel to the receiving station. At the receiver, the impulse corresponding to each wave-train is transformed into a pulse of current and sent through a telephone receiver. Thus, if a dot is signaled by a short group of sparks occurring at the rate of 1,000 per second, at the receiver the telephone will be subjected to the action of a short group of current pulses at this same rate or frequency, and will give off for an instant a musical tone of the frequency 1,000 per second, which corresponds to about the second C above middle C on the musical scale. This short tone signifies to the receiver the transmission of a Morse dot, as a longer tone (produced by a longer group of wave-trains) would mean a dash, and it is by the various combinations of these dots and dashes in monotone that any written message may be spelled out by telegraph.

But in wire telephony conditions are somewhat different. In the first place, it is not required to signal mere time intervals, but the human voice, with its multitude of inflections and tiny variations, must be carried to the receiving station and there reproduced with fidelity. In the second place, the current which carries the voice vibrations must not in itself have any fluctuations unless these occur so rapidly that they will produce no marked effect on the receiving telephone. Otherwise a listener would hear a continual loud noise or tone which would sadly interfere with the transmission of articulate speech. Thus, for wire telephony, a steady flow of direct current has been adopted almost universally as the voice-carrying medium, and speech-wave vibrations are superimposed upon this direct current and reproduced as sound waves by the receiving telephone. Nevertheless, it has been demonstrated that easily understood speech can be transmitted by the use of pulsating or alternating current, so long as the variations are sufficiently rapid to produce of themselves only small effects at the receiver.

In wireless telephony the requirements are analogous. Direct current cannot be transmitted through the air or "ether" from sender to receiver, and so it became necessary to devise a method which would produce in the receiving telephone a steady or practically unvarying stream of direct current. When it is considered that in radio-telegraphy each train of waves creates finally a pulse of direct current, it is not hard to see that if the train of waves were sustained, or indefinitely lengthened, instead of being allowed to cease at the end of each spark, the resulting direct-current pulse would likewise be indefinitely lengthened into a steady flow of direct current. Or, alternatively, one might set up in the receiving telephone very rapid impulses (say at a frequency higher than 5,000 per second) by creating at the transmitter sparks which recur at a similarly high rate and each of which gives rise to a train of waves and a resulting pulse through the telephone. Impulses of such high frequency cannot produce strong individual effects in an ordinary telephone earpiece, and so by their use no interference with speech reproduction is made. Thus, it is evident that as soon as apparatus had been devised for setting up a long stream of sustained waves, or a uniform series of wave-trains at rates above 5,000 per second, one of the biggest obstacles in the path of radio-telephony had been overcome. The largest problem remaining was to find proper instruments for impressing the speech vibrations upon the emitted electromagnetic waves in such a way that their changes would affect the receiving telephone proportionally and so reproduce the vocal sounds. It will be noted that little has been said of the apparatus at the receiver, which collects the radiated waves and, remaining in operation continuously, converts them into current capable of operating a telephone. The development of this group of instruments, of which the essential element is the proportionally responsive "detector," was in itself a tremendous task involving a most radical departure from the typical receivers of early "wireless" telegraphy, and it was soon after its completion that the solution of radio-telephony was found.



Early Fessenden 50,000 cycle alternator, showing driving motor, countershaft and belted pulleys. The dynamo is in the center.

Since spark transmitters were already well known in the art of wireless telegraphy, it is natural that the first work toward producing oscillations and waves for telephony was with apparatus designed to make groups of waves at very high frequencies. A photograph of one of the earliest interrupters, of a type which before 1901 was used by R. A. Fessenden in connection with high-voltage direct current, is shown herewith. The original instrument was intended to allow sparking at the rate of 10,000 per second, and with it reasonably good speech was transmitted by placing in series with its aerial-wire circuit an ordinary carbon microphone telephone transmitter, which rapidly changed its electrical resistance when spoken into and so modified in accordance with voice vibrations the amount of current passing into the antenna. At the receiver the current passing through the telephone earpiece was forced to vary as the sending aerial current was altered, and articulate speech was thus reproduced. In spite of care in building the rotary interrupter spark gap, there were some small irregularities in its action which caused at the receiver such interfering sounds as are sometimes heard on a "noisy wire." Continued work along these lines resulted in better interrupters, but the simultaneous development of the radio-frequency alternator, or dynamo for the direct production of electromagnetic waves, provided a better instrument, and the interrupters were not much used for some years. Upon the adoption of the alternator* it at once became possible to produce perfectly uniform streams of sustained waves. To appreciate this, it is necessary only to understand that the radiant waves of wireless signaling are set up by rapidly alternating electric current in a system of aerial wires or antennæ, and that as the frequency of reversal or alternation of these currents grows greater and greater they set up electromagnetic waves which radiate more and more effectively. Alternating-current dynamos used for power and lighting ordinarily are made to produce from 15 to 60 or 120 periods or cycles of reversal of current in each second. Machines for special purposes are built to generate current of 500 or 1,000 cycles; but since even these relatively high frequencies cannot create vigorous radiation, in 1902 and 1903 a 10,000 cycle alternator was built and used for speech transmission, which proved quite satisfactory, though not entirely perfect. To secure better radiation it was necessary to use still higher frequencies, and therefore, in 1906, there was completed a dynamo giving current of 50,000 or more cycles, which could be connected directly to an aerial circuit and which would cause to be sent out a steady stream of waves. These, when received and "rectified" by the detector, gave in the telephone at the listening station a steady flow of current which was ideal as a basis for wireless speech transmission. The available power was greater than that obtainable when the spark interrupters were used, and this permitted talking to greater

* U. S. Patent 706,737; applied for May 29th, 1901; issued August 12th, 1902.

(Concluded on page 296.)

The Books of 1914

THE accompanying chart, compiled by Fred E. Woodward of Washington, D. C., showing the number and kind of books published in the United States during the year 1914, presents some interesting phases.

A glance at the chart shows a substantial pyramid of blocks or sections, each being marked with names and figures and representing the various divisions or classes into which, for convenience, the books of the year are divided.

The figures are taken from the *Publishers' Weekly*, and represent the actual number of books (by title) issued during the year. The grand total for the year 1914 was 12,010—just 220 less than the total for the year 1913. Of this number, 10,175 were actually new books, and 1,835 were new editions.

A further inspection of the *Publishers' Weekly* shows that American authors contributed 8,563 of this total, and foreign authors, mostly English, the remainder.

The extent to which we are further indebted to Europe is shown by 2,852 importations, the largest number, 330, being in the class known as Religion and Theology, followed by 246 in Fiction; 237 in Poetry and Drama; 223 in General Literature and Essays. The smallest number of importations was in classes known as Domestic Economy (15) and Law (16).

Perhaps the most remarkable growth is shown in the class known as Poetry and Drama—no less than 902 titles being recorded during the year. This class, as will be seen by referring to the chart, now occupies the fourth place, a change from the ninth place in 1913, and an increase of 223 in the year (from 679 to 902).

This growth records in a very forcible manner a decided movement toward poetic and dramatic ideals, which is more than local, and may be heeded by those who read the signs of the times.

Not only have our poets of to-day held their own, but new recruits have been found in the ranks of successful novelists, who, forsaking for a time the fields of romance, have clothed in dramatic form some of their most forcible expressions on the timely topics of the hour.

In the *Literary Digest* of March 1st, 1913, the writer called attention to the little appreciated fact that the proportion of Fiction to the total number of books published had been steadily declining since 1908, when the proportion was 16.1 per cent, to 1912, when it was only 9.3 per cent.

We have now to say that this *declining ratio still continues, and the astonishing figures of 8.77 per cent* are correct for 1914 (1,056 out of 12,010).

This remarkable showing should be gratifying to all who think we publish too much Fiction, and that something more substantial than frivolous stories should engross our attention.

To understand fully how great a transformation has been wrought one has only to go back to the year 1901 to find that the ratio of Fiction to the whole number was 27.4 per cent (2,234 out of 8,141).

It is worthy of note that a large percentage of Fiction published in the United States was written by American authors (689 out of 1,056).

The remarkable growth of books classed as Sociology and Economics began in 1907, in which year 521 books were issued, an increase of 185 over the previous year, and each succeeding year has seen an increase, until 1914, with 1,038 titles in this class, comes within 16 of winning the highest place and crowding out Fiction.

The marked interest shown by all classes of readers in this class of literature, well accounts for its consistent increase.

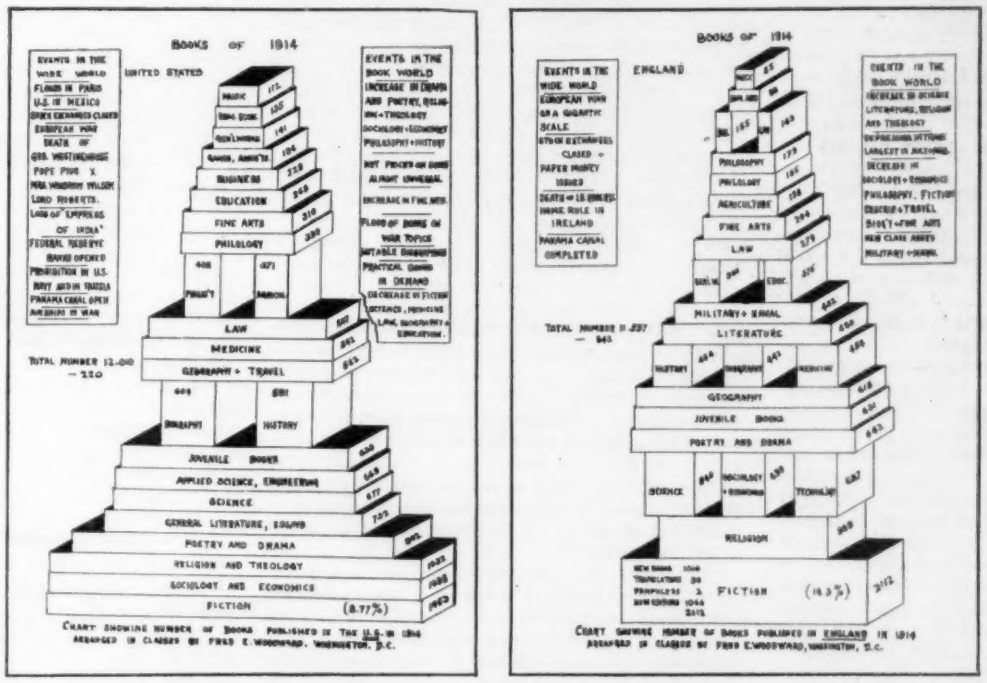
Religion and Theology also has a new record with 1,032 titles, and comes within 21 of Fiction, showing a fairly steady increase each year since 1900.

Philosophy shows a good gain and makes a new record (408 to 324 in 1913), and Fine Arts shows a gain of 46 (310 to 264 in 1913). Juvenile books, General Literature and Essays, Business, Domestic Economy, Music, and General Works are practically the same as last year, but the following show a loss: Science, a loss of 113 (677 to 790 in 1913); Applied Science, 102 (669 to 781 in 1913); Law, 185 (507 to 692 in 1913); Biography, 77 (604 to 681 in 1913); Medicine, 58 (542 to 600 in 1913).

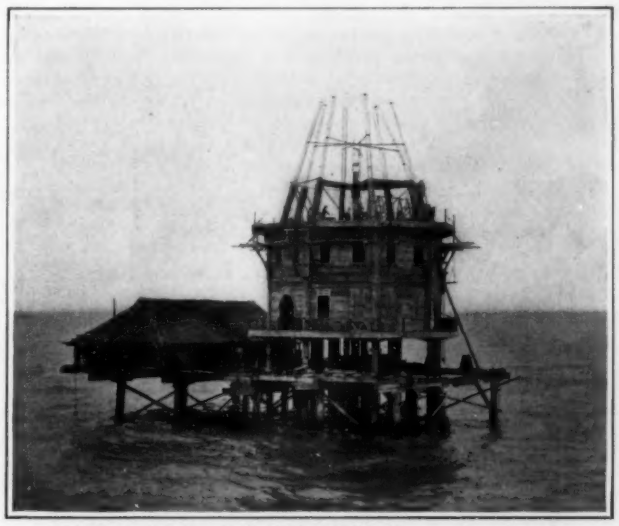
In brief, out of practically the same number of books as in 1913, the year 1914 witnessed a decline in Fiction, Science, Law, Medicine, Biography, and Education, and a gain in Poetry and Drama, Theology and Religion, Sociology and Economics, Philosophy and History, while the remaining classes were changed but slightly from the previous year.

The notes on the margin of the charts are intended to call attention to some of the principal events or happenings both in the book world and in the world at large.

To a certain extent the events in the world are reflected in the books which we issue.



Number of books in various classifications published last year in this country and in England.



Building a lighthouse in Malacca Straits on piles sixty-five feet long.

One-Fathom Bank Lighthouse in the Malacca Straits.

Lighthouse built on a sandy shoal in Delaware Bay.

Rothersand Lighthouse in the North Sea.

War Planes for Italy.—A large order for aeroplanes adapted for war purposes is said to have been recently placed with the Curtiss Aeroplane Company by the Italian government. These machines are to be of 100 horse-power, and are to be fitted with wheels for starting on land, and also with pontoons to enable them to be used at sea. They are to be capable of sustaining about 400 pounds, and are said to cost $7,500 each. It is understood that a large number of these machines are under order, and the Curtiss Company has two representatives with the Italian naval aviation corps to see that the flyers are properly set up and prepared as they are delivered.

Building a Lighthouse on Shifting Sand

By H. J. Shepstone

TO the many notable conquests of the lighthouse engineer we have now to add his triumph in erecting towers upon banks of shifting sand. True, such structures can be counted on the fingers of one's hand, but now that it has been shown that it is possible to place a permanent light upon a sandbank, other beacons will no doubt follow. Hitherto, on account of the extreme difficulties of the work and its high cost, the authorities have been content to mark such menaces to shipping with lightships.

It was the Germans who first showed what could be done in this way by their success in erecting a cylindrical tower upon a shifting shoal near the mouth of the Weser River, known as the Rothersand lighthouse. The water here, at low tide, is only some 23 feet deep, not sufficient for the great liners. Briefly, the plan followed consisted in sinking a huge caisson upon the site, filling it with concrete, and upon this more stable foundation erecting a stone tower. The first attempt proved a failure, and was nothing but a string of accidents.

In the first place considerable difficulty was experienced in towing the caisson to the site and also in sinking it. During the night that followed its settling down upon the bank the workmen who were left upon it experienced an anxious time. Their novel home suddenly began to move and to heel

over to one side. The list grew more pronounced as the hours went by, so much so that the men could not keep their feet, and were forced to remain clinging to the elevated end of the structure. Every moment they expected the caisson to heel over and throw them into the sea. At dawn, however, they were rescued from their perilous position by one of the construction boats. After many weary months of work, when it began to look as if the efforts of the builders would be crowned with success, a terrible gale arose. The men were hastily got off to the mainland, but when they looked across the ocean next morning they could see no sign of the caisson, which had disappeared beneath the waves.

The second attempt, however, proved successful, though several times it looked as if the sea would again rob them of victory. This second caisson was certainly a mighty structure, measuring 46 feet by 36 feet, and towering over 60 feet high when launched. Its shell alone weighed 245 tons, and with the various accessories aboard the weight was brought up to some 335 tons. It was taken out to the site in charge of five tugs, but a sudden thunderstorm coming on, the unwieldy structure broke loose and was washed ashore. At last, however, after many vexatious delays, it was pulled and pushed, nudged and coaxed, to the proper spot. Here it was sunk, the water pumped out, and the men, descending into the lower chamber, removed the sand to allow its edge to sink deeper and deeper into the bank. At the end of twelve months the bottom of the caisson was buried 73 feet below low-water mark, and its weight increased to some 4350 tons. Then, to prevent erosion, huge mattresses of brushwood were sunk around the base of the tower, held down by boat-loads of broken stone. For this protective work alone over 176,000 cubic feet of brushwood and 600 tons of blockstone were requisitioned. The tower rises no less than 75 feet above the top of the caisson, so there is as much below the surface as there is above.

Three years later the United States lighthouse engineers planted an iron tower on Fourteen Foot Bank, over three miles from the shores of Delaware Bay, in twenty feet of water. As in the case of the Rothersand structure, a large caisson was built on shore, towed out to the site, and sunk. It proved a troublesome and weary piece of work, and a most anxious time for all concerned. The caisson refused to settle down properly on the shoal, tilting dangerously to one side, and it was only by the employment of heavy weights and by virtually creating a bed for it that serious trouble was averted. When the huge tub had righted itself concrete was poured into it, forming a solid circular rock sunk into the sand, and as firm and free from vibration as a granite core. Upon this foundation rises a circular iron tower, upon which is perched a house for the keepers, the whole being crowned by a lantern.

The engineer's latest conquest in crowning a dangerous shoal with a permanent light is the recently-completed beacon, known as the One-Fathom Bank lighthouse in the Straits of Malacca, in the East Indies, some sixteen miles off the coast. Until quite recently the waters here were guarded by a lightship, but the position is very open, and so exposed to the full fury of the gales that the vessel frequently dragged her anchors, so that the warning beacon became somewhat uncertain.

In this particular instance, however, the caisson idea was abandoned, and recourse was had to piles, disposed in two concentric rings, the whole being well braced together. When it is stated that the piles go down into the sand till they touch solid rock at a depth of 28 feet, and have each a total length of some 65 feet, it will be seen that their transference to the site and the driving of them into the sea-bed was no mean feat.

The piles, which were made of steel and were hollow, were, in fact, floated to the scene of operations by barrels. Here they were raised and driven home, the final blows being delivered by a "monkey" weighing two and a half tons, dropping from a height of four feet. As the piles disappeared into the sea-bed, they were lengthened by the attachment of further sections. Into them concrete was then poured. These piles support a platform some twenty feet above the surface of the ocean, upon which stands a pretty two-story dwelling, where the keepers live, and where the stores and oil are kept. Thirty feet above this, held aloft by eight columns, comes the lantern.

A New Engineering Medal

LEONARD C. WASON, who has just been elected president of the American Concrete Institute, has offered a new prize to be awarded annually by the Institute to the author of the best paper submitted to the Institute during the year. Competition is restricted to members, and the papers must be original in every respect and not previously published elsewhere. All papers submitted to the Institute for publication in the annual volume are eligible to this competition, but the board has the privilege of withholding the medal any year in which no papers of sufficient merit are presented.

Another Aviator Perishes

TO be obliged to record the death of another aviator, and especially one of the ability and character of Lincoln Beachey, is a matter of great regret, but can hardly be a surprise to those who have witnessed the sensational feats of this brilliant performer. Beachey was drowned at San Francisco on March 14th, when the wings of his monoplane collapsed as he was making one of his terrific vertical dives, and he sank in the waters of the bay strapped to the remains of his machine. The fatal drop was made from a height of about 3,000 feet at the Panama-Pacific Exposition, and after plunging for a great distance head down he attempted to straighten his machine out for his usual graceful landing, when the wings of his new monoplane, a machine of his own design, and of excessively light proportions, crumpled up under the terrific strain, and turning over and over, he fell helplessly into the water.

He had performed this feat repeatedly with biplanes; and with his new monoplane, which was the fastest machine he had handled, he had a few minutes before the accident successfully looped the loop and made an upside down flight. He was considered the most formidable rival of the Frenchman, Pegoud, as a stunt performer; and in this connection it may be noted that it is claimed that Beachey had the loops, spirals, and dives that made Pegoud famous all figured out long before the latter performer startled the world with these feats, but his backers persistently refused to permit him to carry out his plans until Pegoud had proved them possible.

Beachey was one of the earliest air men, having performed for a number of years with little exhibition dirigibles having the well-known cigar-shaped bag, but he did not take up the work with planes for several years after these new craft had become well known, but almost immediately assumed a leading position as one of the most skillful and daring aviators in the world. Beachey was only 31 at the time of his death, but his brilliant feats and modest, unassuming disposition had made him extremely popular with both the public and his fellow flyers.

A Seven-ton Giant Reptile Seven Million Years Old

BETWEEN seven and ten million years ago, in what is known as the Jurassic Age, there lived a group of giant reptiles called Dinosaurs, one family of which, the Stegosauridæ, or plated lizards, is perhaps the most fantastic and curious in all natural history. The most perfect and complete fossilized skeleton of the genus Stegosaurus, a smaller branch of this remarkable family group, is on exhibition in the new building of the U. S. National Museum, at Washington, just as it was found and dug out of the sandstone rock. Near at hand is a natural size and very lifelike restoration in *papier-mache*, so weird and monstrous in appearance as to give one the horrors.

Back in the very early days of the world this armor-plated lizard-like monster dwelt in the western part of the United States in what is now the eastern slope of the Rocky Mountains, although at that time the mountains did not exist. He roamed about in the marsh and swamp lands of that region, feeding on the tropical grasses and plants, the fossil remains of which are found buried with his skeleton. The specimen mentioned above comes from Quarry No. 1, in Fremont County, near Canyon City, Col., where it was found by Mr. M. P. Felch in 1885. Brief articles concerning it were written from time to time, but it was not assembled and mounted until two years ago, and never completely described until recently. With the exception of the removal of some of the sandstone which surrounds this valuable specimen, it has been left in the position in which it was discovered so that the relation of the various bones and skin armor may be seen and studied by scientists. In order that the lower side of the skeleton and the back plates may be seen, two mirrors have been placed beneath it in such a manner as to reflect the exact structure and location of the various bones.

The undisturbed position of the bones and the surrounding sandstone indicate that this monster died in the water or on the bank of a stream, and from some natural cause. It is possible that the carcass floated down the stream, as the arrangement of the different bones and spine plates indicates a gradual washing and tipping over, rather than the crushing action of a heavy force. The skeleton is quite complete and lies partly on its side and back, with nearly all the bones in their relative positions, rendering it of infinite value to scientists for study and as a reference type.

In life this peculiar reptile of such gigantic proportions must have presented a forbidding appearance; it measures about nineteen feet in length, was evidently over eleven feet in height at the hips, and was covered with a very tough and horny scale-like skin, studded here and there with bony buttons or knobs of armor. Along its back were arranged great sharp-edged plates set alternately and projecting upward like the teeth of a huge saw. This odd armor-plate extended from the small wedge-shaped reptilian head all the way back and well down the tapering lizard-like tail, which was tipped with four long, sharp spines. Its legs were not unlike those of a lizard or other reptile, except that the fore legs were rather short and much weaker than the hind ones, an indication that the great animal could sit up like a kangaroo, and perhaps descended from a bipedal ancestor. From a study of its teeth it has been determined that this prehistoric beast was a plant eater, as is suggested by its habitat. Further investigation of its head, which is so small as to be quite out of proportion to its massive body, reveals the fact that it had scarcely any brain. Although the body of the Stegosaurus is supposed to have weighed more than that of an elephant, the brain of the latter is fifty times as heavy, which fact offers an excuse for the immense amount of defensive armor with which it was equipped, making it practically impregnable as far as its enemies were concerned, provided it had any. Its bones alone weigh nearly a ton, and it has been estimated that in life the Stegosaur weighed between seven and ten tons.

A very complete scientific treatise on this interesting group of extinct giant reptiles by Mr. Charles W. Gilmore, assistant curator of fossil reptiles, has just been published by the U. S. National Museum in the form of a bulletin, the edition of which has been distributed to libraries and to scientific and educational institutions.

New Gasoline Engine Drive

TO carry out gasoline engine drive upon various machines which are subject to irregular working, that is, giving rise to shocks at full load and full speed, a belt drive was preferred to couple the motor, for instance, to a thresher. When a brusk shock occurs, the belt can slip on the pulley or even fly off, and this avoids harm to the mechanism and breakage of parts. Realizing the great advantage which would be gained by a direct coupling of motor to thresher and mounting the motor on the same, instead of spending time to set up motor and thresher separately and line up pulleys and belting, a special patented motor combination due to Allart and Savarit is made by the Paris De Dion works. While the use of belt drive can be retained in permanent plants, it will be seen that the direct drive is a great improvement in portable machines. The problem of direct coupling on the class of machine we referred to above has been now successfully solved by the inventors. A flat circular box contains a differential mechanism, with means for slipping on to the end of the machine shaft in place of the usual pulley, such box being then bolted on the side of the thresher, and a short universal joint rod connects the differential to the gasoline motor, which is also mounted against the side of the machine. The motor drives the set of satellite gears. One of the principal gears drives the machine shaft, and on the second large gear is a brake shoe. Brake is set by lever to make its effect equal to what is needed to run the machine (or somewhat higher), but the brake action is adjusted to be less than the maximum of the motor. Normally the motor runs the machine only, for the brake part has the higher effect and is hence idle. But in case of sudden resistance given by the machine, the other side comes into play, that is, the brake wheel is now driven instead of the machine. Such device, while keeping always in gear, runs with constant speed of the motor, or in other words constant power, this being a great advantage.

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Correspondence

The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.]

California's Horse-power Formula

To the Editor of the SCIENTIFIC AMERICAN:

I desire to call your attention to a misprint in the SCIENTIFIC AMERICAN, issue of January 30th, page 95, column 2, under the caption "California Has a New Horse-power Formula."

The formula should read.

$$HP = 0.224\ ND\ (D + L)$$

with the same notation as published.

San Francisco, Cal. J. P. ZIPF.

Light from Film-pack Paper

To the Editor of the SCIENTIFIC AMERICAN:

Referring to the letter "Light from Electricians' Tape," it may interest your correspondent to know that this light also appears in stripping the black paper from film-pack films preparatory to development. In this case, of course, one's eyes are accustomed to the pitch blackness of the dark room, and so the slightest glimmer would be discernible, but I think the light is fully as intense as that given off by the adhesive tape.

New York city. A. F. L.

A Projectile for Destroying Dirigibles

To the Editor of the SCIENTIFIC AMERICAN:

I note in your issue of December 5th, 1914, a projectile useful in the destruction of dirigibles, also in your number of February 13th, in which you show cuts of a projectile which penetrates the balloon fabric and at the same time explodes. I wish to say that several years ago I submitted to the United States Navy at Washington, D. C., drawings and specifications of an incendiary projectile useful in the destruction of dirigibles. The same on piercing the fabric would open knife blades and cut their way through the fabric. The opening of the knife blades causes certain fulminates to ignite or explode the gases in the bag contained therein.

Trenton, N. J. G. GUY MILLER.

How the Late Charles M. Hall Became Interested in Aluminium

To the Editor of the SCIENTIFIC AMERICAN:

I notice that in a recent issue of the SCIENTIFIC AMERICAN you make mention of the death of Charles M. Hall, of aluminium fame.

You might be interested to know that it was the reading of the SCIENTIFIC AMERICAN that first interested Mr. Hall in a method of extracting aluminium from the clay earths.

I distinctly remember being at his father's home in the fall of the year 1880, when he was about sixteen years of age. One Sunday afternoon, in taking a walk with him, he explained to me that there was a valuable metal contained in the clay which abounds in northern Ohio, with many of the qualities of copper, and that if a cheap method of extracting the same could be found, the metal would be of very great use in the arts. Although he was a little older than myself, I expressed my incredulity, but he assured me that he had read about the matter in the SCIENTIFIC AMERICAN and it could be depended upon.

I think there is no question but that beginning from his perusal of the SCIENTIFIC AMERICAN when he was a mere boy, he never gave up his determination to find a method for the production of aluminium until he, while still a very young man, succeeded in his purpose.

Manchester, Iowa. E. B. STILES.

Ventilating the New Subways

To the Editor of the SCIENTIFIC AMERICAN:

I have given considerable attention to the subways as to the easiest and best method of ventilating them and make the air as pure as we breathe in the streets, since the first tube was built to the present tubes in course of construction in the city of New York.

Take the Seventh Avenue and Broadway tubes, where improvements in ventilating could be easily installed at a small expense over the original cost.

The openings into the tubes for entrances and exits will probably be similar to the other tubes, each about from 4 feet wide to 8 feet high, through which the air will pour in, and in order to give perfect vent to the tubes, use pipes 2 and 4 feet in diameter 15 feet high from the ground, with a goose-neck top; place near the gutter on the sidewalk or against the houses, and run pipes of the same dimensions from the side of the tube and connect with the pipes above the sidewalk, and in each opening into the tube for the pipes a fan should be installed, to cause a circulation. Stations five blocks apart, with two openings for exits and two openings for entrances on one side of the avenue or street and the same number on the other side, making eight openings in all, each 4 by 8 feet, on each side of the tube on the street between stations; there should be eighteen goose-neck pipes, 2 by 4 feet in width, and you will have a subway free from all bad odors, the smoke from fires and oppressive heat, and the air in the tubes will be as pure as we breathe in the street. Fans must be used to cause a suction in the pipes; without fans the wind will blow down.

If the pipes are 15 feet high above the walk, the tops would not be tampered with, and no rubbish could be thrown within. Goose-neck tops prevent down draughts to a considerable degree.

The above plans would not suffice where sidewalk ventilators are installed. There would have to be more pipes used unless the gratings were covered.

New York city. J. WESLEY SMITH.

Sir Hiram Maxim on the Maxim Gun in War

To the Editor of the SCIENTIFIC AMERICAN:

I am sending you inclosed a newspaper cutting and also a note that was handed in to me by Mr. D. George Collins, a very important business man, who has great influence in political matters. Like myself he is a chevalier of the Legion of Honor.

On Sunday last a soldier from the front called at my residence. He had been wounded and had returned home. He said he wished to see the inventor of the Maxim gun before he returned to the front. He told us that on the Kaiser's birthday the Germans charged in solid formation, their object being to rush the English trenches and bayonet the defenders, but the British had three Maxim guns concealed and ready for them, and when they suddenly opened fire the stream of bullets cut regular canals through the Germans and that very few of them escaped. He said from his own experience at the front he believed that more than one half of the casualties of the present war were due to the Maxim gun. He said that if they had not had the Maxim guns they would have stood no chance whatsoever against the enormous German forces that were sent against them. The Maxim gun, without question, had saved the situation. He asked permission to shake hands with me. HIRAM S. MAXIM.

West Norwood, London, S.E.

P. S.—An English officer has said that the Maxim gun lends itself much more to the defense than to the attack. H. S. M.

[The following is the cutting sent by Sir Hiram Maxim: "In Paris last week I met an officer who stated that in one of the big engagements the English had fifteen Maxim guns. They were masked by lines of British infantry. The Germans attacked in swarms, and as they came within short range the British soldiers opened out, fell back, and the Maxim guns in three minutes left dead 5,000 of the Germans. The Germans did not expect the guns to be concealed behind the ranks of soldiers."—D. George Collins, February 9th, 1915.]

Acoustics of Auditoriums

To the Editor of the SCIENTIFIC AMERICAN:

"Acoustics of Auditoriums," by F. R. Watson, in SUPPLEMENT, No. 2031, was interesting to me, from the fact that in 1889 I had the privilege of hearing a Mormon elder in the Tabernacle at Salt Lake, where, as is well known, a pin dropped at the pulpit can be heard in the extreme rear. On my way to Philadelphia it occurred to me that few buildings possessed those acoustic properties. Not being scientifically educated, I must tell you in common language what I reasoned out in 1889—then a young man—which may help some builder.

The ideal building for the easy flow of sound waves is hemispherical, and it also is equally valuable to the return or echo waves. Curtains and wall ornaments retard the return of echo waves, but they also prevent the easy flow of the original waves from the stage. So that walls free of draperies are nearer the ideal. To produce an echo in a hall or auditorium the sound waves first reach the extreme rear and returning mix with either their own waves traveling sidewise or with new sound waves, which are stronger, forcing them to the sides of the building. I concluded then that the nearest approach to the perfect auditorium would be a hemisphere, without draperies on walls, and standing on stage looking toward audience, all lines would be streamlines, or as I said in 1889, lines of beauty; and standing at rear, looking toward stage, all lines would be irregular; also at rear, equidistant along both sides, would be a recess or alcove. Looking from the stage no break in the walls or ceiling would be noticeable. The sounds would travel unobstructedly; looking from the rear the walls and ceiling would resemble somewhat the gills of a fish, which would prevent to a great extent echo waves. A building so constructed would, I think, make it difficult for the original sound waves to reach the stage from the rear, if the orator stood at the rear and tried to make his words reach the stage. A building constructed on those lines would also open up a new world for the artistic painter.

A smooth rear wall helps the echo waves. The alcove or recess I mention would be in center rear wall as a "sound catcher." When the sound waves reach the rear wall they have performed their duty and should die there. T. E. PHILLIPS.

Jack Wade, Alaska.

Musical Pitch to the Eleventh Decimal

To the Editor of the SCIENTIFIC AMERICAN:

In your December 26th, 1914, issue is a communication from Mr. E. H. Hawley giving the vibration numbers of the notes of the equally tempered musical scale. This is based on international a' with 435 vibrations per second. The long strings of figures after the decimal points look so important that it seems in order to call attention to the futility of such calculations, and the fact that they have no significance musically. Let us consider the c'' . . . 517.30509506692. If this c'' is sounded with the a' 435 an imperfect minor third results, since the perfectly harmonious minor third should make 522 vibrations per second (6/5 equals 522/435). In other words this equally tempered minor third is sufficiently flat to produce nearly five beats in a second. If the table gave the vibration number of c'' as 517.30509506693 (last figure three instead of two) this c'' would be a higher pitch than the c'' figured by Mr. Hawley, and would make one vibration more in one hundred billion seconds. As there are only 86,400 seconds in a day the two c'''s if sounded continuously together would require well over 3,000 years for each beat. It is hard to see how figures in this class can properly apply to any musical problems, practical or theoretical.

It would appear also that the vibration numbers given for the siren disk of the "optophone" are merely copied from the extended table already discussed without regard for the established practice when discarding decimal figures. As the optophone will have a certain whole number of holes in each circle, the vibration numbers cannot be made to correspond so closely to the figures of the equally tempered musical scale.

Schenectady, N. Y. JOHN B. TAYLOR.

How to Make Carbon Positives

To the Editor of the SCIENTIFIC AMERICAN:

The following method of making positives on glass is an adaptation of the well-known gum bichromate process. Briefly, it consists of making gum bichromate prints on ground glass, then varnishing the latter to give the required transparency.

Coating: Coat with the following:

(A) Potassium bichromate (saturated sol.), ⅔ ounce.

(B) Gum arabic (saturated sol.), 1 ounce.

(C) Lamp-black (or equivalent color), 40 grains.

B is prepared by suspending 2 ounces of clear gum contained in a muslin sack in six ounces of distilled water. Allow to stand for at least twenty-four hours. Mix A and B. Put the lamp-black on a clean ground glass, add a little of the gum solution, and grind with a glass strip to a uniform consistency. After grinding carefully and thoroughly, mix this with the remainder of the solution.

Coat the ground glass surface of the plates with a camel's hair brush, using just enough of the solution in each instance to give a uniform dark gray tint when viewed by transmitted light. A second soft brush should be used to even the coating as much as possible so as to obliterate brush marks which would show in the finished print. The coated plate must *not be opaque* in any part. The plate should be dried in the dark, which takes only a few minutes to accomplish. The writer uses a small bake oven placed near a stove as a drying oven.

Exposure: An average negative will require from three to five minutes in bright sunlight.

Development: Soak in cold water for several minutes, then gradually raise the temperature of the water until development begins. The exposure should be so timed that development proceeds automatically, as any mechanical assistance other than moving the plate gently through the water will destroy the finer details. Because of the rigid glass backing, the image is easily destroyed by even a slight touch of a soft brush. Hence, soak the plate face down, for several hours if need be, until finished.

When the development is completed, dry and varnish with a quickly drying pale oil varnish. Pour a pool of varnish on the center of the plate, allow to flow over the entire surface, drain, and dry face up in a place protected from dust. Mount in cardboard frames with *passe-partout* binding.

Some causes of failure: Brush marks are due to uneven coating. Loss of detail, or damaged image, may be due to rough handling in development. Too thick a coating of gum-pigment results in the film's peeling off in development. CLAUDE C. KIPLINGER.

Department of Chemistry, Iowa State College, Ames, Iowa.

over to one side. The list grew more pronounced as the hours went by, so much so that the men could not keep their feet, and were forced to remain clinging to the elevated end of the structure. Every moment they expected the caisson to heel over and throw them into the sea. At dawn, however, they were rescued from their perilous position by one of the construction boats. After many weary months of work, when it began to look as if the efforts of the builders would be crowned with success, a terrible gale arose. The men were hastily got off to the mainland, but when they looked across the ocean next morning they could see no sign of the caisson, which had disappeared beneath the waves.

The second attempt, however, proved successful, though several times it looked as if the sea would again rob them of victory. This second caisson was certainly a mighty structure, measuring 46 feet by 36 feet, and towering over 60 feet high when launched. Its shell alone weighed 245 tons, and with the various accessories aboard the weight was brought up to some 335 tons. It was taken out to the site in charge of five tugs, but a sudden thunderstorm coming on, the unwieldy structure broke loose and was washed ashore. At last, however, after many vexatious delays, it was pulled and pushed, nudged and coaxed, to the proper spot. Here it was sunk, the water pumped out, and the men, descending into the lower chamber, removed the sand to allow its edge to sink deeper and deeper into the bank. At the end of twelve months the bottom of the caisson was buried 73 feet below low-water mark, and its weight increased to some 4350 tons. Then, to prevent erosion, huge mattresses of brushwood were sunk around the base of the tower, held down by boat-loads of broken stone. For this protective work alone over 176,000 cubic feet of brushwood and 600 tons of blockstone were requisitioned. The tower rises no less than 75 feet above the top of the caisson, so there is as much below the surface as there is above.

Three years later the United States lighthouse engineers planted an iron tower on Fourteen Foot Bank, over three miles from the shores of Delaware Bay, in twenty feet of water. As in the case of the Rothersand structure, a large caisson was built on shore, towed out to the site, and sunk. It proved a troublesome and weary piece of work, and a most anxious time for all concerned. The caisson refused to settle down properly on the shoal, tilting dangerously to one side, and it was only by the employment of heavy weights and by virtually creating a bed for it that serious trouble was averted. When the huge tub had righted itself concrete was poured into it, forming a solid circular rock sunk into the sand, and as firm and free from vibration as a granite core. Upon this foundation rises a circular iron tower, upon which is perched a house for the keepers, the whole being crowned by a lantern.

The engineer's latest conquest in crowning a dangerous shoal with a permanent light is the recently-completed beacon, known as the One-Fathom Bank lighthouse in the Straits of Malacca, in the East Indies, some sixteen miles off the coast. Until quite recently the waters here were guarded by a lightship, but the position is very open, and so exposed to the full fury of the gales that the vessel frequently dragged her anchors, so that the warning beacon became somewhat uncertain.

In this particular instance, however, the caisson idea was abandoned, and recourse was had to piles, disposed in two concentric rings, the whole being well braced together. When it is stated that the piles go down into the sand till they touch solid rock at a depth of 28 feet, and have each a total length of some 65 feet, it will be seen that their transference to the site and the driving of them into the sea-bed was no mean feat.

The piles, which were made of steel and were hollow, were, in fact, floated to the scene of operations by barrels. Here they were raised and driven home, the final blows being delivered by a "monkey" weighing two and a half tons, dropping from a height of four feet. As the piles disappeared into the sea-bed, they were lengthened by the attachment of further sections. Into them concrete was then poured. These piles support a platform some twenty feet above the surface of the ocean, upon which stands a pretty two-story dwelling, where the keepers live, and where the stores and oil are kept. Thirty feet above this, held aloft by eight columns, comes the lantern.

A New Engineering Medal

LEONARD C. WASON, who has just been elected president of the American Concrete Institute, has offered a new prize to be awarded annually by the Institute to the author of the best paper submitted to the Institute during the year. Competition is restricted to members, and the papers must be original in every respect and not previously published elsewhere. All papers submitted to the Institute for publication in the annual volume are eligible to this competition, but the board has the privilege of withholding the medal any year in which no papers of sufficient merit are presented.

Another Aviator Perishes

TO be obliged to record the death of another aviator, and especially one of the ability and character of Lincoln Beachey, is a matter of great regret, but can hardly be a surprise to those who have witnessed the sensational feats of this brilliant performer. Beachey was drowned at San Francisco on March 14th, when the wings of his monoplane collapsed as he was making one of his terrific vertical dives, and he sank in the waters of the bay strapped to the remains of his machine. The fatal drop was made from a height of about 3,000 feet at the Panama-Pacific Exposition, and after plunging for a great distance head down he attempted to straighten his machine out for his usual graceful landing, when the wings of his new monoplane, a machine of his own design, and of excessively light proportions, crumpled up under the terrific strain, and turning over and over, he fell helplessly into the water.

He had performed this feat repeatedly with biplanes; and with his new monoplane, which was the fastest machine he had handled, he had a few minutes before the accident successfully looped the loop and made an upside down flight. He was considered the most formidable rival of the Frenchman, Pegoud, as a stunt performer; and in this connection it may be noted that it is claimed that Beachey had the loops, spirals, and dives that made Pegoud famous all figured out long before the latter performer startled the world with these feats, but his backers persistently refused to permit him to carry out his plans until Pegoud had proved them possible.

Beachey was one of the earliest air men, having performed for a number of years with little exhibition dirigibles having the well-known cigar-shaped bag, but he did not take up the work with planes for several years after these new craft had become well known, but almost immediately assumed a leading position as one of the most skillful and daring aviators in the world. Beachey was only 31 at the time of his death, but his brilliant feats and modest, unassuming disposition had made him extremely popular with both the public and his fellow flyers.

A Seven-ton Giant Reptile Seven Million Years Old

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The undisturbed position of the bones and the surrounding sandstone indicate that this monster died in the water or on the bank of a stream, and from some natural cause. It is possible that the carcass floated down the stream, as the arrangement of the different bones and spine plates indicates a gradual washing and tipping over, rather than the crushing action of a heavy force. The skeleton is quite complete and lies partly on its side and back, with nearly all the bones in their relative positions, rendering it of infinite value to scientists for study and as a reference type.

In life this peculiar reptile of such gigantic proportions must have presented a forbidding appearance; it measures about nineteen feet in length, was evidently over eleven feet in height at the hips, and was covered with a very tough and horny scale-like skin, studded here and there with bony buttons or knobs of armor. Along its back were arranged great sharp-edged plates set alternately and projecting upward like the teeth of a huge saw. This odd armor-plate extended from the small wedge-shaped reptilian head all the way back and well down the tapering lizard-like tail, which was tipped with four long, sharp spines. Its legs were not unlike those of a lizard or other reptile, except that the fore legs were rather short and much weaker than the hind ones, an indication that the great animal could sit up like a kangaroo, and perhaps descended from a bipedal ancestor. From a study of its teeth it has been determined that this prehistoric beast was a plant eater, as is suggested by its habitat. Further investigation of its head, which is so small as to be quite out of proportion to its massive body, reveals the fact that it had scarcely any brain. Although the body of the Stegosaurus is supposed to have weighed more than that of an elephant, the brain of the latter is fifty times as heavy, which fact offers an excuse for the immense amount of defensive armor with which it was equipped, making it practically impregnable as far as its enemies were concerned, provided it had any. Its bones alone weigh nearly a ton, and it has been estimated that in life the Stegosaur weighed between seven and ten tons.

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THE discoveries of the last few years have shown that an atom is quite a world in itself, and as the properties of atoms are of importance in so many branches of science, the article on Recent Evidence for the Existence of the Nucleus Atom, in the current issue of the SCIENTIFIC AMERICAN SUPPLEMENT, No. 2047, for March 27th, 1915, will be read with more than usual interest. Watching the Earth Revolve describes a simple instrument that enables us to directly observe and measure the revolution of the earth. The Economies of Home Lighting surveys the various systems of lighting, and makes comparisons of cost of direct value to every householder. The Science of the Tariff tells of one of the ways in which science has been called to the aid of the Government. An Airship in the Field is the personal story of a member of the crew of a big German Zeppelin, describing a voyage of observation. Photographing Projectiles gives a series of pictures illustrating a series of experiments in this interesting field, together with useful notes. Making Steel by Electricity illustrates the construction of the most important furnaces devised for this important branch of manufacture, together with many details and much valuable information. There is an interesting story on the history of the celebrated "Damascus" sword blades, and the article on the Reaction of the Planets Upon the Sun is concluded, besides much other information.

Correspondence

The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.]

California's Horse-power Formula

To the Editor of the SCIENTIFIC AMERICAN:

I desire to call your attention to a misprint in the SCIENTIFIC AMERICAN, issue of January 30th, page 95, column 2, under the caption "California Has a New Horse-power Formula."

The formula should read.

$$HP = 0.224\ ND\ (D + L)$$

with the same notation as published.

San Francisco, Cal. J. P. ZIPF.

Light from Film-pack Paper

To the Editor of the SCIENTIFIC AMERICAN:

Referring to the letter "Light from Electricians' Tape," it may interest your correspondent to know that this light also appears in stripping the black paper from film-pack films preparatory to development. In this case, of course, one's eyes are accustomed to the pitch blackness of the dark room, and so the slightest glimmer would be discernible, but I think the light is fully as intense as that given off by the adhesive tape.

New York city. A. F. L.

A Projectile for Destroying Dirigibles

To the Editor of the SCIENTIFIC AMERICAN:

I note in your issue of December 5th, 1914, a projectile useful in the destruction of dirigibles, also in your number of February 13th, in which you show cuts of a projectile which penetrates the balloon fabric and at the same time explodes. I wish to say that several years ago I submitted to the United States Navy at Washington, D. C., drawings and specifications of an incendiary projectile useful in the destruction of dirigibles. The same on piercing the fabric would open knife blades and cut their way through the fabric. The opening of the knife blades causes certain fulminates to ignite or explode the gases in the bag contained therein.

Trenton, N. J. G. GUY MILLER.

How the Late Charles M. Hall Became Interested in Aluminium

To the Editor of the SCIENTIFIC AMERICAN:

I notice that in a recent issue of the SCIENTIFIC AMERICAN you make mention of the death of Charles M. Hall, of aluminium fame.

You might be interested to know that it was the reading of the SCIENTIFIC AMERICAN that first interested Mr. Hall in a method of extracting aluminium from the clay earths.

I distinctly remember being at his father's home in the fall of the year 1880, when he was about sixteen years of age. One Sunday afternoon, in taking a walk with him, he explained to me that there was a valuable metal contained in the clay which abounds in northern Ohio, with many of the qualities of copper, and that if a cheap method of extracting the same could be found, the metal would be of very great use in the arts. Although he was a little older than myself, I expressed my incredulity, but he assured me that he had read about the matter in the SCIENTIFIC AMERICAN and it could be depended upon.

I think there is no question but that beginning from his perusal of the SCIENTIFIC AMERICAN when he was a mere boy, he never gave up his determination to find a method for the production of aluminium until he, while still a very young man, succeeded in his purpose.

Manchester, Iowa. E. B. STILES.

Ventilating the New Subways

To the Editor of the SCIENTIFIC AMERICAN:

I have given considerable attention to the subways as to the easiest and best method of ventilating them and make the air as pure as we breathe in the streets, since the first tube was built to the present tubes in course of construction in the city of New York.

Take the Seventh Avenue and Broadway tubes, where improvements in ventilating could be easily installed at a small expense over the original cost.

The openings into the tubes for entrances and exits will probably be similar to the other tubes, each about from 4 feet wide to 8 feet high, through which the air will pour in, and in order to give perfect vent to the tubes, use pipes 2 and 4 feet in diameter 15 feet high from the ground, with a goose-neck top; place near the gutter on the sidewalk or against the houses, and run pipes of the same dimensions from the side of the tube and connect with the pipes above the sidewalk, and in each opening into the tube for the pipes a fan should be installed, to cause a circulation. Stations five blocks apart, with two openings for exits and two openings for entrances on one side of the avenue or street and the same number on the other side, making eight openings in all, each 4 by 8 feet, on each side of the tube on the street between stations; there should be eighteen goose-neck pipes, 2 by 4 feet in width, and you will have a subway free from all bad odors, the smoke from fires and oppressive heat, and the air in the tubes will be as pure as we breathe in the street. Fans must be used to cause a suction in the pipes; without fans the wind will blow down.

If the pipes are 15 feet high above the walk, the tops would not be tampered with, and no rubbish could be thrown within. Goose-neck tops prevent down draughts to a considerable degree.

The above plans would not suffice where sidewalk ventilators are installed. There would have to be more pipes used unless the gratings were covered.

New York city. J. WESLEY SMITH.

Sir Hiram Maxim on the Maxim Gun in War

To the Editor of the SCIENTIFIC AMERICAN:

I am sending you inclosed a newspaper cutting and also a note that was handed in to me by Mr. D. George Collins, a very important business man, who has great influence in political matters. Like myself he is a chevalier of the Legion of Honor.

On Sunday last a soldier from the front called at my residence. He had been wounded and had returned home. He said he wished to see the inventor of the Maxim gun before he returned to the front. He told us that on the Kaiser's birthday the Germans charged in solid formation, their object being to rush the English trenches and bayonet the defenders, but the British had three Maxim guns concealed and ready for them, and when they suddenly opened fire the stream of bullets cut regular canals through the Germans and that very few of them escaped. He said from his own experience at the front he believed that more than one half of the casualties of the present war were due to the Maxim gun. He said that if they had not had the Maxim guns they would have stood no chance whatsoever against the enormous German forces that were sent against them. The Maxim gun, without question, had saved the situation. He asked permission to shake hands with me. HIRAM S. MAXIM.

West Norwood, London, S.E.

P. S.—An English officer has said that the Maxim gun lends itself much more to the defense than to the attack. H. S. M.

[The following is the cutting sent by Sir Hiram Maxim: "In Paris last week I met an officer who stated that in one of the big engagements the English had fifteen Maxim guns. They were masked by lines of British infantry. The Germans attacked in swarms, and as they came within short range the British soldiers opened out, fell back, and the Maxim guns in three minutes left dead 5,000 of the Germans. The Germans did not expect the guns to be concealed behind the ranks of soldiers."—D. George Collins, February 9th, 1915.]

Acoustics of Auditoriums

To the Editor of the SCIENTIFIC AMERICAN:

"Acoustics of Auditoriums," by F. R. Watson, in SUPPLEMENT, No. 2031, was interesting to me, from the fact that in 1889 I had the privilege of hearing a Mormon elder in the Tabernacle at Salt Lake, where, as is well known, a pin dropped at the pulpit can be heard in the extreme rear. On my way to Philadelphia it occurred to me that few buildings possessed those acoustic properties. Not being scientifically educated, I must tell you in common language what I reasoned out in 1889—then a young man—which may help some builder.

The ideal building for the easy flow of sound waves is hemispherical, and it also is equally valuable to the return or echo waves. Curtains and wall ornaments retard the return of echo waves, but they also prevent the easy flow of the original waves from the stage. So that walls free of draperies are nearer the ideal. To produce an echo in a hall or auditorium the sound waves first reach the extreme rear and returning mix with either their own waves traveling sidewise or with new sound waves, which are stronger, forcing them to the sides of the building. I concluded then that the nearest approach to the perfect auditorium would be a hemisphere, without draperies on walls, and standing on stage looking toward audience, all lines would be streamlines, or as I said in 1889, lines of beauty; and standing at rear, looking toward stage, all lines would be irregular; also at rear, equidistant along both sides, would be a recess or alcove. Looking from the stage no break in the walls or ceiling would be noticeable. The sounds would travel unobstructedly; looking from the rear the walls and ceiling would resemble somewhat the gills of a fish, which would prevent to a great extent echo waves. A building so constructed would, I think, make it difficult for the original sound waves to reach the stage from the rear, if the orator stood at the rear and tried to make his words reach the stage. A building constructed on those lines would also open up a new world for the artistic painter.

A smooth rear wall helps the echo waves. The alcove or recess I mention would be in center rear wall as a "sound catcher." When the sound waves reach the rear wall they have performed their duty and should die there. T. E. PHILLIPS.

Jack Wade, Alaska.

Musical Pitch to the Eleventh Decimal

To the Editor of the SCIENTIFIC AMERICAN:

In your December 26th, 1914, issue is a communication from Mr. E. H. Hawley giving the vibration numbers of the notes of the equally tempered musical scale. This is based on international a' with 435 vibrations per second. The long strings of figures after the decimal points look so important that it seems in order to call attention to the futility of such calculations, and the fact that they have no significance musically. Let us consider the $c''' \ldots 517.30509506692$. If this c''' is sounded with the a' 435 an imperfect minor third results, since the perfectly harmonious minor third should make 522 vibrations per second (6/5 equals 522/435). In other words this equally tempered minor third is sufficiently flat to produce nearly five beats in a second. If the table gave the vibration number of c'' as 517.30509506693 (last figure three instead of two) this c''' would be a higher pitch than the c''' figured by Mr. Hawley, and would make one vibration more in one hundred billion seconds. As there are only 86,400 seconds in a day the two c''''s if sounded continuously together would require well over 3,000 years for each beat. It is hard to see how figures in this class can properly apply to any musical problems, practical or theoretical.

It would appear also that the vibration numbers given for the siren disk of the "optophone" are merely copied from the extended table already discussed without regard for the established practice when discarding decimal figures. As the optophone will have a certain whole number of holes in each circle, the vibration numbers cannot be made to correspond so closely to the figures of the equally tempered musical scale.

Schenectady, N. Y. JOHN B. TAYLOR.

How to Make Carbon Positives

To the Editor of the SCIENTIFIC AMERICAN:

The following method of making positives on glass is an adaptation of the well-known gum bichromate process. Briefly, it consists of making gum bichromate prints on ground glass, then varnishing the latter to give the required transparency.

Coating: Coat with the following:

(A) Potassium bichromate (saturated sol.), ⅜ ounce.

(B) Gum arabic (saturated sol.), 1 ounce.

(C) Lamp-black (or equivalent color), 40 grains.

B is prepared by suspending 2 ounces of clear gum contained in a muslin sack in six ounces of distilled water. Allow to stand for at least twenty-four hours. Mix A and B. Put the lamp-black on a clean ground glass, add a little of the gum solution, and grind with a glass strip to a uniform consistency. After grinding carefully and thoroughly, mix this with the remainder of the solution.

Coat the ground glass surface of the plates with a camel's hair brush, using just enough of the solution in each instance to give a uniform dark gray tint when viewed by transmitted light. A second soft brush should be used to even the coating as much as possible so as to obliterate brush marks which would show in the finished print. The coated plate must *not be opaque* in any part. The plate should be dried in the dark, which takes only a few minutes to accomplish. The writer uses a small bake oven placed near a stove as a drying oven.

Exposure: An average negative will require from three to five minutes in bright sunlight.

Development: Soak in cold water for several minutes, then gradually raise the temperature of the water until development begins. The exposure should be so timed that development proceeds automatically, as any mechanical assistance other than moving the plate gently through the water will destroy the finer details. Because of the rigid glass backing, the image is easily destroyed by even a slight touch of a soft brush. Hence, soak the plate face down, for several hours if need be, until finished.

When the development is completed, dry and varnish with a quickly drying pale oil varnish. Pour a pool of varnish on the center of the plate, allow to flow over the entire surface, drain, and dry face up in a place protected from dust. Mount in cardboard frames with *passe-partout* binding.

Some causes of failure: Brush marks are due to uneven coating. Loss of detail, or damaged image, may be due to rough handling in development. Too thick a coating of gum-pigment results in the film's peeling off in development. CLAUDE C. KIPLINGER,

Department of Chemistry, Iowa State College, Ames, Iowa.

The Superheated Steam Unit

Some Remarkably Economical German Engines

By Warren H. Miller, M. E.

THERE are three advantages inherent in the use of superheated steam; first, the fundamental law of thermodynamics, which states that the greatest efficiency follows when the given medium is used at the highest possible temperature and rejected at the lowest; second, the fact that superheated steam does not readily condense on cold cylinder walls, thus resisting the heavy losses that follow from cylinder condensation; finally, superheated steam occupies a greater volume per pound than saturated steam—at 300 deg. Cent. superheat is 1.26 times the volume of the same steam saturated—so that a pound of it will do more work than a pound of saturated steam.

Its practical disadvantages when used in an ordinary steam plant are so many that little progress in its use has been made in the United States. The ratio of heat interchange between chimney flue gases and the superheated steam inside the superheater is so small as to make a clean, non-sooted metal surface an essential (Gutermuth, *Versuche über die heissdampf Lokomobilen*, 1910). In lokomobile practice the superheater is blown clear of soot every twelve hours with an especial revolving steam jet for the purpose.

Again, a sufficiently high superheat to eliminate cylinder condensation is only reached around 570 deg. Fahr. and this comprises reheating of the high-pressure exhaust before admitting to the low-pressure cylinder in order to eliminate the cylinder condensation there. The valve gear and lubrication facilities of an ordinary steam engine will not do well at such high temperatures, and to carry superheated steam long distances from boiler- to engine-room, back to reheater and return to low-pressure cylinder of an engine at temperatures of 570 degrees and 450 degrees, respectively, is out of the question with ordinary commercial steam pipe packing.

Third, a tubular boiler designed to evaporate a maximum of saturated steam is in no way suited to be used with a superheater. Its tubes are of such a length as to deliver the flue gases to the uptake at about 410 deg. Fahr., while what is wanted for efficient superheating is around 800 to 900 degrees. With water-tube boilers this disadvantage does not hold, since the superheater can be located with more freedom.

These disadvantages of the ordinary steam plant led to the development in Europe of the superheated steam unit or "lokomobile," described by the writer in the columns of the SCIENTIFIC AMERICAN, March 9, 1912, p. 213. During the last fifteen years over 60,000 of them have been built, aggregating four million horse-power. In general principles they are all founded on the idea of compactly assembling everything needed to make and use superheated steam in one unit. The engine is mounted on the boiler, even in 1,000 horse-power units; the fire tubes are short and the remainder of the smoke box is occupied by one or more superheaters. The boiler is internally fired, with corrugated furnace; there is no radiation and no long line of piping from boiler to engine.

Owing to the successful utilization of highly superheated steam, these units develop remarkable economies, averaging less than 1.5 pounds of coal and 10 pounds of steam per brake horse-power in all sizes from 40 horse-power to 1,000 horse-power, and not losing this notable economy appreciably at either underloads or overloads.

This astonishing statement has been proved beyond question by hundreds of tests made during the last ten years by such eminent European authorities as Profs. Josse of Berlin, Gutermuth of Darmstadt, Mathot of Brussels, Burstall of London, and Schroeter of Munich. I give below summaries of ten of the more important lokomobile tests made upon various sizes of Wolf lokomobiles.

A description of the various superheated steam units that figured in the above tests may prove interesting, for they cover the whole range of lokomobile practice from the earlier types of 1900 to the latest construction, the compound uniflow cylinder 300 to 800 horse-power line recently put on the market by the R. Wolf Company of Magdeburg, Germany.

Beginning with Test 1, Wolf, 180 horse-power, tested by Gutermuth in 1901, the following description will give a fair idea of the general construction. The boiler is of the horizontal tubular type, with removable tubes and corrugated shell furnace, permitting easy and thorough cleaning. Owing to the very low fuel and water consumption of the lokomobile it is feasible to use a compact internally fired boiler, for even in the 250 horse-power size the grate is only about 4 feet 6 inches by 3 feet 6 inches in area. The tubes are much shorter than those of a saturated steam boiler. Not only have they much less steam to evaporate to produce a horse-power, but they must deliver the flue gases to the superheater at a high temperature, 700 to 900 deg. Fahr. In front of the tube sheet is the superheater coil, bearing a ratio to the boiler heating surface of about 250 to 75. In front of this is a revolvable steam jet pipe, used daily for the purpose of blowing off the soot and ash, an essential feature in order to get real efficiency from the superheater.

On the rear end of the boiler is a cast iron shell, containing high and low pressure cylinders. This shell is riveted to the boiler and is not only the steam dome, but also a live steam jacket for both cylinders. At the forward end of the boiler is riveted the crank-shaft saddle, and since the engine stresses pass through the boiler shell, the alignment and adjustment of valve laps and center distances are made under full steam pressure and working temperature.

The steam from the boiler is led inside the shell to the front and passes through it by a double lock nut joint to the superheater. The steam is at about 160 pounds boiler pressure (11 atmospheres) and the superheater gives it a temperature around 570 degrees, whence it passes direct to the engine by a short, heavily insulated pipe. The expansion is divided between the two cylinders so as to allow the steam to enter the low pressure cylinder with as much superheat left as possible, so as to eliminate cylinder condensation in that cylinder also. Lokomobiles of this type are good for 10 to 11 pounds of steam per brake horse-power hour.

The next advance in the lokomobile was to turn the engine around and mount the cylinders tandem, as in Figs. 1, 2, and 3, placing the low-pressure cylinder as before in a sort of steam-dome jacket with the high-pressure behind it in a casting, forming part of the chimney uptake. Turning the engine around also made the steam piping problem easy, so that a second superheater was introduced between the high and low-pressure cylinders, for it was found out that cylinder condensation would occur in the low unless excessive superheats were carried. This second superheater was made multiple coil, as it had to handle large volumes of steam at low pressures. It takes the steam from the high-pressure cylinder at about 260 deg. Fahr. and reheats it to 380 degrees, the flue gases entering the chimney at about 430 degrees after passing through this superheater and passing around the walls of the high-pressure cylinder. This type of engine is made in sizes from 40 to 80 horse-power and the 40 horse-power size as tested by Prof. Josse in 1904 gave a steam economy of 10.9 pounds per brake horse-power hour.

This was surpassed by the later type shown in Fig. 4. In this lokomobile the steam-dome jacket feature has been discarded entirely, and both cylinders are mounted tandem in a hood over the smoke box; the main chimney uptake leading out of this hood. Otherwise all the general features of the previous type have been retained. It is made in sizes from 130 horse-power to 650 horse-power, and at present holds, so far as I am aware, the world's record of steam and coal economy at 7.05 pounds of steam and 0.79 pound of coal per brake horse-hour. This was obtained only, however, by the excessive superheat of 806 deg. Fahr., though neither engine nor lubricating oil showed any distress at that temperature. As the reader will note by Test 4, the ordinary economy of this type at 626 degrees superheat is between 8 and 9 pounds.

Test No. 5 is of an interesting lokomobile, Fig. 5, a representative of the 300 to 800 horse-power line, cross-compound, double superheat. It was the 650 horse-power engine of this type which, running in parallel with a 1,000 horse-power Lanz lokomobile, furnished a large part of the electric light and power used in the Brussels Exposition of 1910. It probably represents the limit both in size and economy of the steam dome-jacketed piston-valve engine. The double superheat feature appears also in this lokomobile, and as tested by the Exposition judges it gave 8.70 pounds of coal and 1.02 pounds of steam per brake horse-hour on a superheat of 649 deg. Fahr.

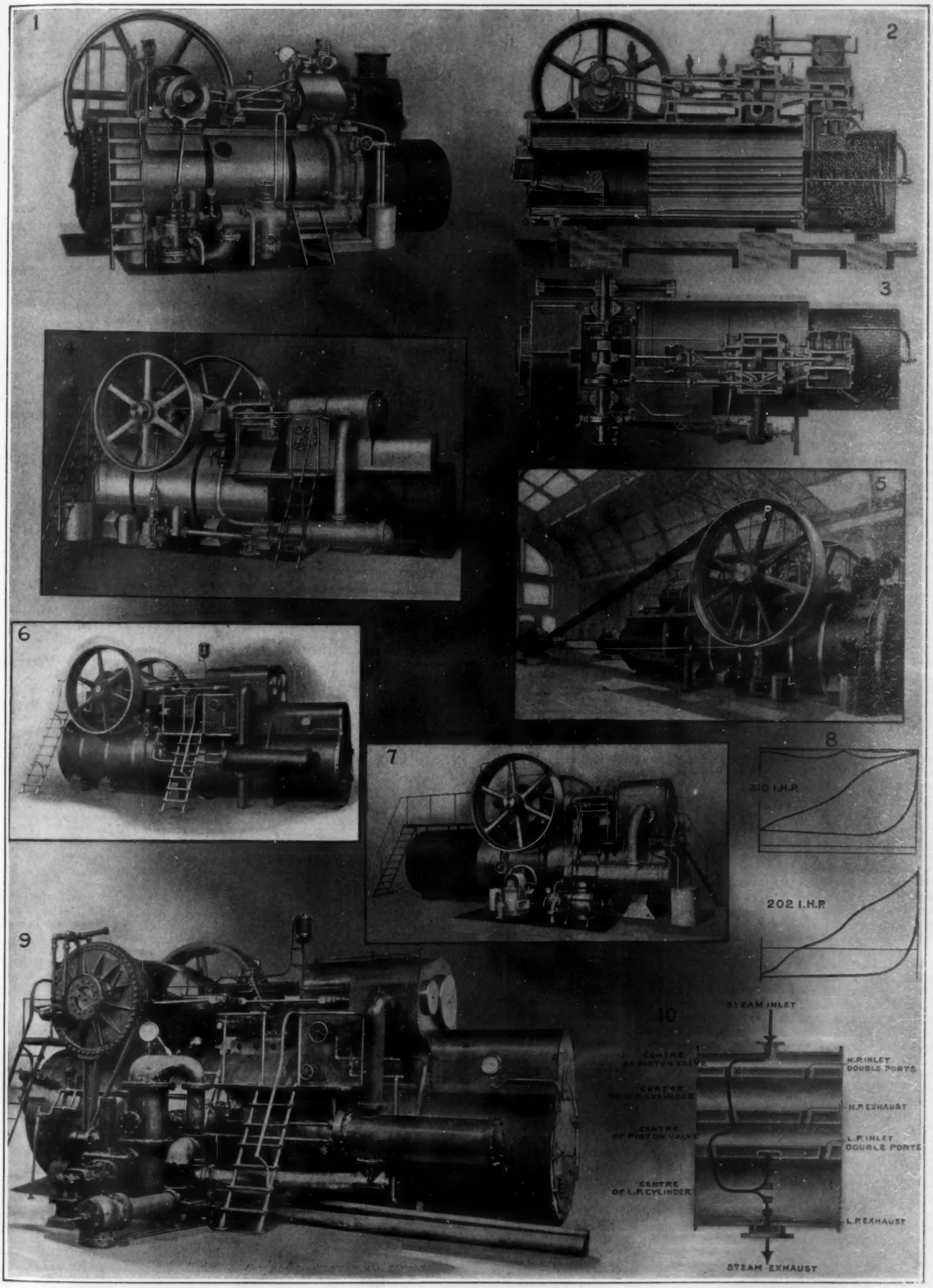
During the last two years the Wolf Company has developed what may be termed the latest advance in the lokomobile—the application of the uniflow cylinder principle to these superheated steam units. The test results, as obtained by Prof. Doerfel of Prague, are given in No. 6. Note that an economy of 8.9 pounds of steam was obtained on a superheat of 644 deg. Fahr., a remarkably low consumption with superheat well within the limits of practical operation. It may seem like double use to employ both superheated steam and the uniflow cylinder principle to eliminate cylinder condensation, but whatever is good for saturated steam is as good for superheated, wherefore the uniflow type. Briefly described, the steam passes into the cylinder by the inlet port, produces the stroke in expanding, and then escapes by a central outlet port uncovered by the piston at the end of the stroke. There is thus no exhaust stroke with its cooling effect on the cylinder walls; in fact, the passage of the steam in one direction only produces a set of annular differential temperature areas on the cylinder walls corresponding closely to the varying temperatures of expansion, so that the tendency toward cylinder condensation is very small. Further, it has been found that the use of constricted cylinder ports alternately by hot live steam and cold exhaust steam at every stroke introduces a lot of condensation before the steam ever gets into the cylinder at all, and this loss the uniflow arrangement eliminates entirely. (Engine and cards shown in Figs. 7 and 8.)

To work this out in practice the Wolf Company engineers had to devise a cross-compound uniflow cylinder engine. This was done by making the pistons of both cylinders relatively long in proportion to the stroke and putting in piston valves to control admission to high and low-pressure cylinders. The exhaust ports of the high-pressure cylinder are on the opposite side from the inlet ports and are located somewhat further inward toward the center of the cylinder instead, as shown in the diagram. These ports are uncovered by the piston toward the end of the expansion stroke and the steam thus escapes to the low-pressure receiver. It is admitted to the low-pressure cylinder and then prevented from "backing up" into the high-pressure by the low-pressure piston valve during the succeeding stroke. Part of it is trapped in the high-pressure cylinder and serves as a cushion during the return, but a real exhaust stroke, such as has been tolerated in ordinary

(Concluded on page 296.)

No.	Date	Manufacturer	Horse-power	Coal (pounds).	Steam (pounds).	Superheat Degs. Fahr.	By Whom Made.	Type of Lokomobile.
1	1901	Wolf	180	1.5 per B.H.P. hour	11.2 per B.H.P. hour	570	Prof. Gutermuth, Darmstadt	Cross compound, single superheat.
2	1904	Wolf	432	1.32 per B.H.P. hour	10.9 per B.H.P. hour	590	Prof. Josse, Berlin	Tandem compound, double superheat.
*3	1910	Wolf	138	0.789 per B.H.P. hour	7.05 per B.H.P. hour	806	Magdeburg Boiler Association	Tandem compound, double superheat, chimney cylinder jacketing.
4	1910	Wolf	105	1.04 per B.H.P. hour	8.69 per B.H.P. hour	626	Prof. Gutermuth, Darmstadt	Tandem compound, double superheat, chimney cylinder jacketing.
5	1910	Wolf	520	1.02 per B.H.P. hour	8.70 per B.H.P. hour	649	Brussels Exposition, Test Committee	Cross compound, double superheat, steam cylinder jacketing.
6	1912	Wolf	300	.....	8.9 per B.H.P. hour	644	Prof. Doerfel, Prague	Cross compound, uniflow cylinder, single superheat.
7	1913	Buckeye Engine Co.	169	1.08 per I.H.P. hour	9.2 per I.H.P. hour	588	Geo. Cooper, Buckeye Eng. Co., Salem, O.	Tandem compound, double superheat, chimney cylinder jacketing.
8	1909	Lanz	120	0.805 per B.H.P. hour	7.41 per B.H.P. hour	.....	Prof. Grossmann, Karlsruhe	Cross compound, "ventil" valve gear.
9	1908	Lanz	249	1.1 per B.H.P. hour	9.74 per B.H.P. hour	680	Prof. Schröter, Munich	Cross compound, "ventil" valve gear.
10	1910	Lanz	1105	1.08 per B.H.P. hour	9.65 per B.H.P. hour	676	Brussels Exposition, Test Committee	Cross compound, "ventil" valve gear.

* World's record.



1. Forty horse-power tandem compound Wolf "lokomobile" or superheated steam unit with double superheat and high-pressure cylinder jacketed in the chimney uptake. 2 and 3. Sectional elevation and plan of same. 4. World's record Wolf lokomobile, 150 horse-power 0.72 pound of coal per brake horse-power-hour consumption. Double superheat and both cylinders jacketed in smoke hood. 5. Cross compound 600 horse-power Wolf lokomobile at Brussels Exposition. Double superheat and both cylinders jacketed in the steam dome. 6. "The Buckeyemobile" or first American superheated steam unit, virtually a copy of No. 4. 7. The Wolf uniflow cylinder compound condensing lokomobile, the latest advance in superheated steam units, 300 to 800 horse-power. 8. High-pressure and low-pressure cylinder card from No. 7. 9. The first American superheated steam unit with Alden dynamometer. 10. Diagram showing course of steam through the Wolf uniflow high and low-pressure cylinders.

The superheated steam unit.

An Aerial Monorail

Mähl System for High Speed Suspended Electrical Trains

An outline of a new system of high speed monorail trains moved by electricity was one of the interesting features recently discussed in Paris, as the constant desire for greater speed in trains has been uppermost in the minds of railway engineers for a long time. It seems evident that the limit by existing methods has practically been reached, and if the speeds of to-day are to be surpassed methods based on different principles must be adopted. One hundred and twenty miles an hour has already been attained in experiments with electric traction (Zossen in 1902) but this rate is clearly incompatible with two tracks resting on the earth and following ordinary railway construction. On curves especially great strains are developed which, even with present speeds, result in breaks and derailments; and with higher speeds these would be more probable, and the resulting accidents more disastrous even than those of to-day.

It is much more philosophical to seek the development of high speeds through the elevated monorail mounted on pillars, for here high speed is really possible with light, articulated cars suspended from flexible running gear, the many wheels of which would serve to distribute the weight along the rail. The applications of such a principle are by no means confined to places where speed is the desideratum. Such railways are already used for mines and quarries, for factories and for rope railways carrying passengers, as at Chamonix and other places in Switzerland, and are not without value for regular traffic, as for example the Barmen-Elberfeld road in Rhenish Prussia, the eight miles of which have been in operation since 1901.

It is a road of this kind that is suggested by Mähl, an engineer of Paris who is well known for his studies in the transmission of power, who has just submitted to the Minister of Public Works detail plans for trains with speeds up to one hundred and eighty miles an hour. In the Mähl system, the track, whether single or double, is from twenty to twenty-five feet above the ground, with towers or pylons, and the familiar suspension-bridge catenary cables between them. The conveyances are to be long, light, articulated cars, the joints affording them the ability to conform to the curves in the line. There will be no grade crossings nor tunnels, and the difficulties that are inherent in present road-bed construction and current systems of running will be avoided.

The plans consider curves of a minimum radius of six-tenths of a mile and grades up to five per cent. The pylons are square at the base and of dimensions varying according to the needs. The longitudinal vertical section of these is triangular, the average height to the top being about fifty feet, and the transverse vertical section is hour-glass shaped, the upper portion serving to hold and spread the cables and furnish vertical support from above to the rails, while the cars hang in the neck of the hour-glass, or the angle formed by the upper and lower sections of the tower.

The tower must be well anchored on hard pan or rock, without depending on surface stability; and it will be practicable to use rocky gorges without much consideration of surface levels; even the beds of streams will furnish the route for such a railway. The distribution of the towers may be varied to suit conditions, but with an average distance between them of about one hundred and fifty to two hundred feet. The sag of the cables is about twenty-five feet, and the rails will be supported by them at such a height that the cars extending ten feet below them will leave fifteen or twenty feet in the clear.

The cars will be composed of tractor elements and accessories and vehicle elements. The former will include the motors which are independent and tandem on the rail, at intervals of a little more than a yard. The cars are about one hundred and fifty feet long and one meter wide, generally rectangular in shape with the inner lower corner rounded, and fitted with but one row of seats, back to the inner wall. The cars will have some lateral play, swinging out of the perpendicular in one direction or the other on rounding curves. The articulation is a minor feature designed to adapt the cars more closely to the curves; but there is only about a quarter of an inch play at each joint, an amount that will not be perceptible to the passengers.

The track will be divided into sections of five kilometers each (3 miles) and a train will always have automatically two dead sections behind it forming a perfect block system and avoiding collisions. On entering a section the train automatically cuts off the current from the section just quitted, and turns it on to the third section in the rear. The intermediate sections will be left in its currentless condition. There are thus always live sections ahead for the train with clear track, but lack of current and automatic braking if there is a train within three sections. The projector asserts that it will be safe to run under such conditions with only a two minute headway.

Switching is to be done by means of moving sections of rail that will take a car and provision is made for removing obstructions on the rail or snow by means of a plow on the forward motor hood. The plans call for ties and braces to support the rail, completing a light but strong structure competent to carry not only the weight of the train but to withstand the strains due to wind pressure and the centrifugal force that the train will exert at curves.

The monorails are to be T pattern, and in the spans between the towers they may be joined by fish-plates or welded. Interlocking joints will prevent all shocks and consequent injury to the rails, and at the towers there will be provisions for expansion.

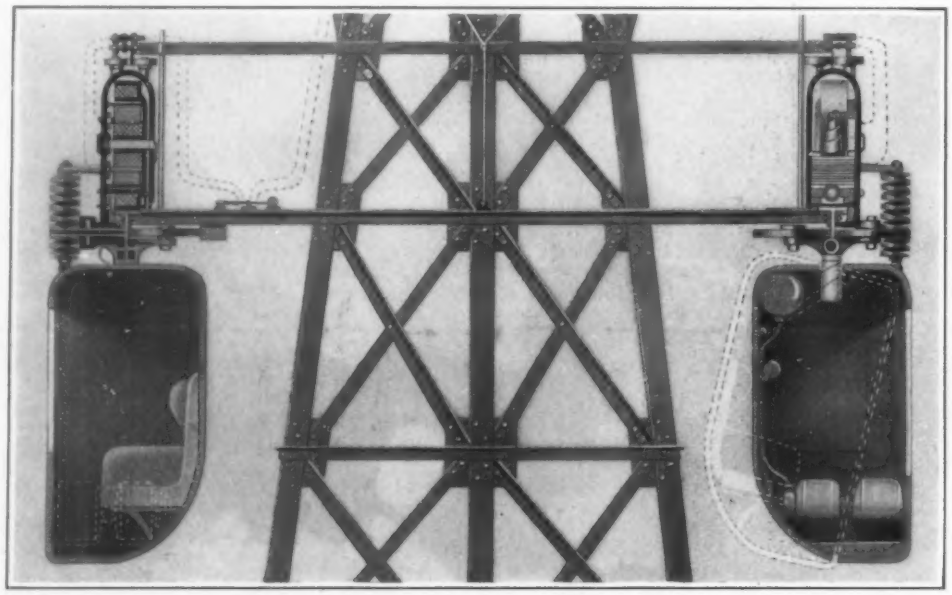
The motors will be of special pattern, the stators being fastened to the frame of the car while the motor wheels will be without flanges. Friction rollers below the rail will guard against accidents of derailment. For heavy grades provision is made for donkey-motors, taking current from a super-rail, which will run above the top of the car and make flying connection while the car is slowing up at the grade. The motor will precede the car slowing gradually till it has the same speed and will then by electrical action link itself to the car. At the top of the grade the current of the donkey will be cut off automatically, it will uncouple itself and then be ready to return for another tow.

The cars are to be fish-shaped in front and similarly rounded at the rear, and the mechanician in his cab in the forward compartment is surrounded by devices of report and control. One of these matters is lubrication. High speeds are apt to cause heating of bearings, and it is proposed to enclose in every axle a thermostat which will give notice to the mechanician of any undue rise in temperature. There is an elaborate plant for lubricating, a pump, pipes to each bearing, etc., so that, as in some lathe or automobile processes, there is a constantly flowing stream of oil. The mechanician will have at hand the means of increasing the flow at the bearing which sends warning and thus bridge the difficulty.

In addition to the care expended on a smooth and continuous rail the provision of shock absorbers is suggested, and springs are provided to reduce to a minimum the swing from centrifugal force, which will be merely a sway of small amplitude even at high speeds. The brakes are springs released by electro-magnetic action, and once applied they cannot be released until the train has been brought to a stop.

As to the cost, the French estimate, which can hardly apply to this country, is twenty thousand dollars for a car fifty meters in length weighing fifty-five tons with a carrying capacity of two hundred. With the passengers the weight on the rail will therefore be not far from a ton and one-half to a meter. For such weights, and to sustain the other strains the cost of construction of the way, including electrical instalment, according to the estimate, is between eighty and ninety thousand dollars a mile. This does not include, however, the power house and its sources of energy.

Some of the computations of strains and other items may be of interest. For the catenary suspension of such a railway as has been discussed four cables of a diameter of 50 millimeters each (2 inches) will be ample. The centrifugal effect, with two trains on the tracks, referred to the base of the towers is figured at 8 kilogrammes per square millimeter, while it is 6 kilogrammes on the rails themselves. So far as wind pressure on the cables and structure is concerned, the amount is figured to be only about one third of that of the centrifugal force under usual conditions of weather, while that on the train is perhaps double the value of the centrifugal force, these strains being well within the strength of usual constructions. The resistance of the air rises very rapidly with the speed, being 1,230 foot-pounds for 75 kilometers an hour; 10,000 for 150 kilometers, and 80,000 foot-pounds for 300 kilometers. The energy required for running on a level rising rapidly with the speed, being for level stretches 29 kilowatts and 223 kilowatts, respectively, for the three speeds. On grades of 50 millimeters to the meter the corresponding kilowatt figures are 745, 1,500, and 3,080.



Details of construction of a monorail line, showing section of cars, method of constructing tracks, and of suspending and driving the cars.

At the left is seen the motor and switches controlling the current; at the right is the braking apparatus. The large spiral springs control the swing of the car under the influence of centrifugal force.

The Detoxication of Coffee

PERSONS with a sensitive stomach are affected not so much by caffeine as by the products formed in roasting the coffee. The effects in such cases are not nervous, but digestive, and they may be so pronounced that the person affected cannot drink coffee at all.

The object of recent experiments was to eliminate from coffee the harmful products of roasting, without, at the same time, removing the caffeine, to which the coffee owes its stimulating effect. A procedure is used by means of which the coffee bean is covered, during the process of roasting, with certain substances, such as for instance, kaolin or china clay, which absorbs the poisonous products. The clay is applied either in form of a paste, or is made to adhere to the beans by means of the moisture which escapes when they are roasted. By means of its capillary qualities, the clay absorbs the products of roasting, the oils and resins formed being thus eliminated from the surface and the upper stratum of the coffee bean.

Prof. Görbing made a series of practical tests with coffee detoxicated in this manner. He found that seventeen persons who were unable to take ordinary coffee, were not made to suffer the slightest effects when they drank his coffee. With nine other persons detoxicated coffee agreed better than ordinary coffee, and in one case only was there no difference between the two.

Radio outfit in a side car.

Field radio telegraph and telephone station using a motorcycle power plant.

Radio Telephone and Telegraph Equipment on a Motorcycle

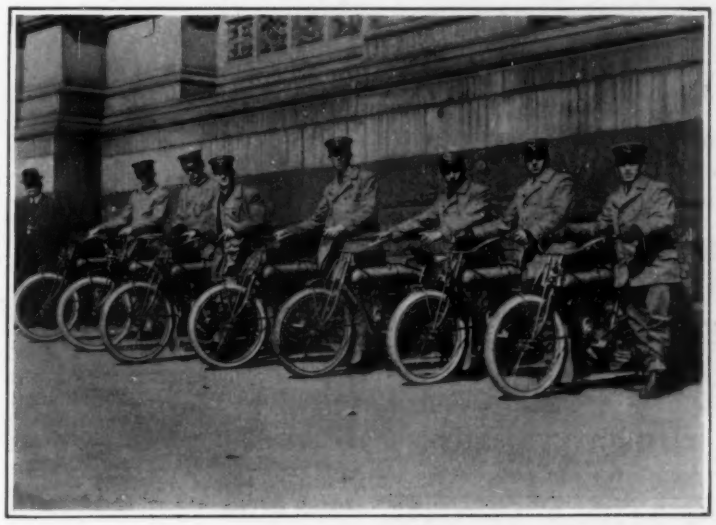
A MOTORCYCLE radio telephone and telegraph set has recently been devised by a New York inventor for use by armies on the march or in the field. The equipment is contained in a metal side car attached to the motorcycle. The transmitting power is approximately one kilowatt with a resultant radius for the wireless telegraph of eighty to one hundred miles and about half that distance for the radio telephone.

Current is supplied to the telephone or telegraph by a high voltage direct current generator connected directly to an independent motorcycle engine contained within the sidecar. In this connection mention should be made of the fact that the wireless equipment comprises a complete unit entirely independent of the motorcycle. It can be readily detached and pushed by hand or loaded upon a wagon and transported over rough ground. An extra wheel is provided, which can be attached to either hub of the side car or to the front or rear of the motorcycle.

The antenna is supported by a light weight metal mast of tubular construction. The form is telescopic, so that the mast when collapsed can be easily strapped out of the way on the side of the car.

Motorcycle Mail Delivery

THE Brooklyn Post Office is trying an experiment in the handling of special delivery mail. A letter or parcel bearing a special delivery stamp travels no faster than the rest of the mail, but on arriving at the post office station of its destination it must be delivered immediately. Where there are but few letters to be delivered considerable expense is involved if they must be taken out without delay by the usual car. Evidently a lighter vehicle would do equally as well, and so in Brooklyn a test of motorcycle delivery is being made. So far three of the twenty-two stations have motorcycle carriers. The machines are bought by the men and operated at their own expense. They are paid for their services at the rate of eight cents for each letter or parcel delivered. This service has only just been installed, and it is impossible at this early date to judge of its success.



Motorcycle mail delivery.

State Must Pay for Highway Accident.—A decision of great importance has been handed down by the New York Supreme Court in the case of a garage owner, whose car was wrecked upon a public highway, because the laborers on the road had left an iron spike on the side of the road, which spike caused the garage owner's automobile to overturn. The court held broadly that "any State that undertakes to 'maintain' roads within its boundaries for the traffic of vehicles, thereby automatically assumes all responsibility for damages and losses which may be sustained by people using such roads."

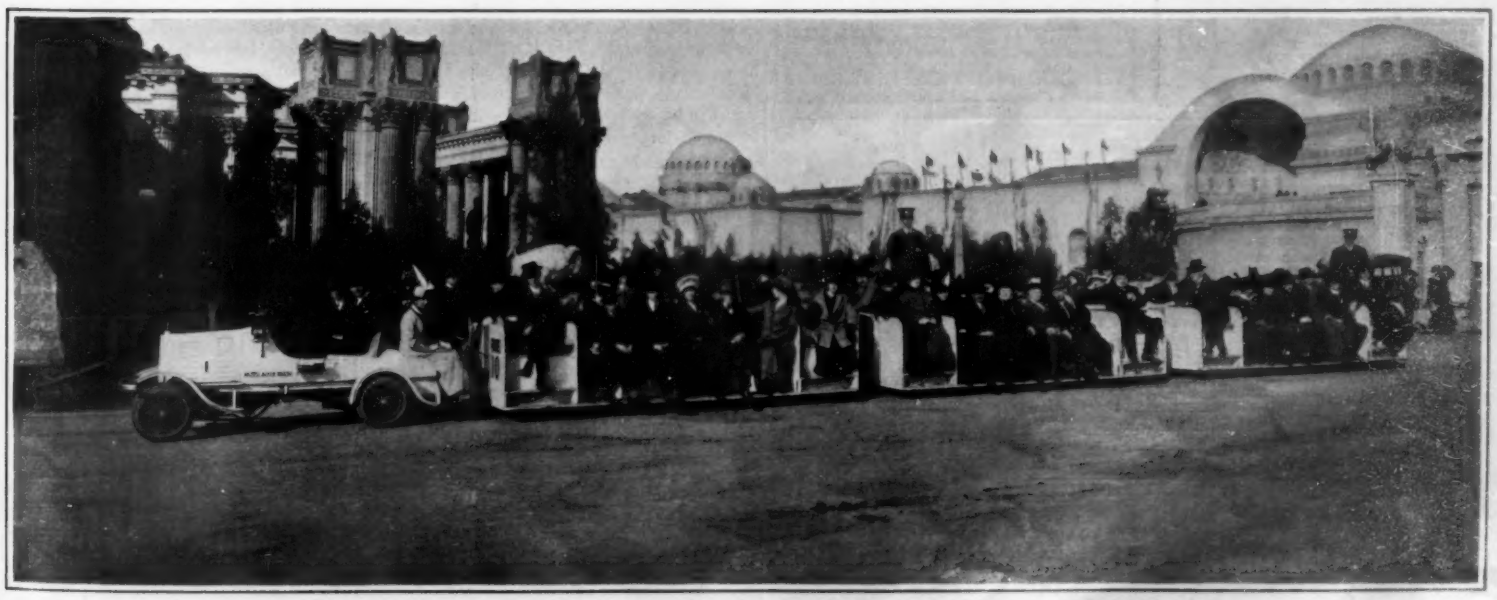
Motor Tractor Trains at the Exposition

ONE of the notable features of the Panama-Pacific Exposition is the system of sight-seeing automobile trains that skim about beautiful Jewel City, conveying thousands of exposition visitors over the extensive grounds, and affording them a complete and comprehensive view of the great fair in its exterior aspect. These midget trains were invented by R. B. Fageol of Oakland, California, who recognized the need of an efficient, economical and popular solution of the transportation problem within the grounds of the Exposition.

In detail each train consists of a special miniature motor tractor and two specially designed trailers or cars resembling a double settee with the conductor's aisle in the center. The braking system consists of a shoe connected midway in the drawbar, which is forced downward when the motion of the train is slackened, the action being automatic and in unison with the tractor, making it absolutely safe in crowds. The system is an entirely new invention which successfully solves a hitherto perplexing problem.

The whole car is but one step off the ground, running on four invisible wheels, all controlled by a drawbar connection to the tractor in such a way that the two cars follow in exactly the same tracks as the tractor when rounding a turn in the road. This feature eliminates any cutting off on turns or crowding of people off the road. Each train seats forty people comfortably.

An Electrically Controlled Shock Absorber.—In patent No. 1,123,404 W. T. Sears of Philadelphia, Pa., provides in connection with a shock absorber, which can be employed in connection with automobiles and the like, means by which variable resistance may be secured in a positive and certain manner through the aid of electro-magnets of any suitable form by which he can automatically magnetically vary the frictional or other checking effect applied to the relatively movable members of the shock absorber.



Sight-seeing automobile train, a popular feature of the Panama-Pacific International Exposition.

Protecting you from the old mistakes of creation—

SAYS BERNARD SHAW: "When a man puts a Formamint lozenge into his mouth to wipe out a few million bacteria, he is trying to correct one of the old mistakes of creation." And nothing ever summed up so completely the service that Formamint renders.

For Formamint offers what thousands of physicians endorse as a most trustworthy means of forestalling sore throat itself and tonsillitis and many other of the "old mistakes of creation"—i.e., *germ infections*—which get into the system by way of the throat.

Formamint is a little, candy-like tablet that you let dissolve in your mouth. In the saliva it frees a germicide, fatal to germs but harmless to the most delicate membranes. And flowing into every tiny corner of the gums, tonsils and throat, into places where no gargle ever reaches, it most effectively *disinfects* the throat.

You will find it excellent for sore throat—but you will find the *regular* habit of taking Formamint much more important to your health for the simple reason that it *safeguards* the throat from germ invasion. At all druggists.

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The Ideal Junior Power Mower will keep the lawn in the finest condition, and delight everyone who takes pride in the proper appearance of his lawn.

This power driven mower is more economical to operate than either the hand or horse driven mower—will do the work quicker and better. Ten full hours work costs but 20 cents for fuel—with no loss of power, as is the case when three or four chains are necessary to transmit the power from the motor to the drive wheel.

The motor is 3 h.p. SAE rating, high tension National magneto: 4 adjustable cutter blades; 25-inch cut; climbs 40 grades; cuts 5 acres per day. Speed up to 4 miles per hour.

The Ideal Combination Mower and Roller, a larger machine with 38-inch cut - - $400.

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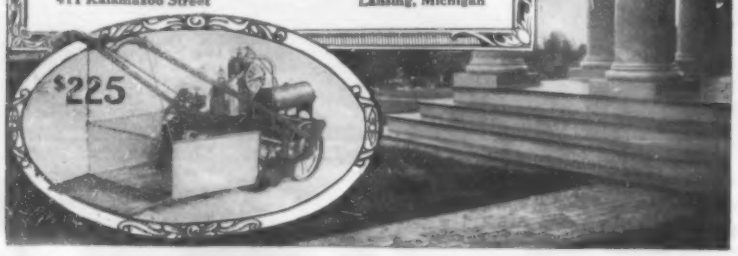

Notes for Inventors

Who Will Devise a Non-mirror Show Window?—A merchant tells the writer of the desirability of some means for effectively preventing the mirror effect in show windows, the effect we all notice in passing such a window in which our image is reflected and the contents of the window are shut out of view. Naturally the shopkeeper who works for a display in his window resents its not being seen. Some attempts we are told have been made, but there seems to be room for a simple effective remedy for the suggested difficulty.

Synchronizes Co-operative Musical Instrument.—The Aeolian Company of New York, as assignee of Samuel S. Waters of Washington, D. C., has secured patent No. 1,128,923 in which there is a main musical instrument having a perforated sheet which wholly controls, through suitable means, the operation of the record of an auxiliary musical instrument so the two instruments will operate in perfect time with each other.

Wrapper Unwraps the Cigar.—Milton Wertheimer of Baltimore, Md., in patent No. 1,128,828 provides a wrapped cigar with the end of the wrapper beyond those of the cigar twisted in the same direction so that by pulling its twisted ends the wrapper will unwind or open to expose the cigar.

A Piano Without Strings.—In patent No. 1,128,112 issued to J. C. Deagan of Chicago, Ill., is presented what is termed a piano without strings. The vibrating body is in the nature of a xylophone made of wood, metal or other vibrating material which may be set into vibration by any suitable means such as a hammer and the sound waves are modified or influenced by resonating tubes shown one within the other with their sound receiving ends toward the vibrating bar.

Your Hands and the Golf Club.—In playing golf a careful player will consume considerable time in properly positioning the club in his hands to bring it in proper position with respect to the ball. To facilitate this A. W. Hayford of Swampscott, Mass., has patented, No. 1,126,208, a golf club in the grip of which is embedded a positioning or aligning device running lengthwise of the shaft and projecting from it in such manner as to serve as a gage in gripping the club.

Chairman Oldfield Retires from Patent Committee.—On March 4th, the Hon. W. A. Oldfield, chairman of the House of Representatives' Committee on Patents, retired from that committee, as at that time he went on the Ways and Means Committee and retired from all other committees under the rule of the House. He has been an active energetic chairman, ever ready to urge with all his might that which he thought should be supported by his committee. He has also shown a warm interest in the Patent Office and only a few weeks ago delivered an address in the Patent Office building to the examining corps of that office. It is likely that he will be succeeded in the chairmanship by the Hon. Martin A. Morrison of Indiana, who will be the senior Democratic member of the committee.

A Ticket Holder Wanted.—A retail clothing man says that the trade needs a ticket holder for holding the price and lot tickets to a coat or other garment, which holder can be easily applied to and removed from the garment and will permit its ticket to be removed and another inserted, all without mutilation of or other injury to the garment.

Bill Lost After Passing Congress.—The Patent Office reorganization bill after it had passed both houses of Congress was, in some way, lost before it was signed by the President, and therefore failed of becoming a law, since it was not approved before noon on March 4th. To become a law it must be re-introduced and advanced anew in the Sixty-fourth Congress. As the law was only expected to become effective in July, 1916, the incident may not affect the operation of the Patent Office. The bill provided for two additional examiners-in-chief, one additional law examiner and for eighty-six assistant examiners in each of the four grades. When it becomes a law it will result in promotions all along the line of the examining corps. How the bill, after passing the Senate, was lost and failed to reach the President for signature, is still a mystery.

Patent Office Assignment Records.—We have in these columns repeatedly referred to the assignment records of patents. In his report of January 30th, 1915, to Congress, Commissioner Ewing refers to the frequent necessity of ascertaining what patents are owned by a particular individual firm or corporation and goes on to say that there is no authentic manner at present in which such search can be made except in each of the volumes wherein are recorded assignments and the data of the application, where they are indexed from assignor to assignee. Mr. Ewing in the report urges the importance of establishing and maintaining a consolidated assignee index and states that requests are frequently made for such an authentic, verified, and checked index, from which a reliable search may be made to ascertain what patents are owned by given corporations, firms, or individuals. To perform this service it is believed that three more index clerks will be required in addition to those now employed in the Assignment Division, and for the indexing covering the past 17 years five or six additional clerks will probably be needed to bring up its arrearage within a reasonable time. The Commissioner will submit at an early date to Congress a request for authority to establish this index and a request for additional clerks for this purpose.

A Classification Index for the Official Gazette.—Beginning with the issue of Tuesday, April 6th, the Patent Office *Gazette* will for the first time print a classification index; that is to say, an index of the different classes with the numbers of the patents of the respective issues. This will enable a subscriber to the *Gazette* to determine without any trouble all the patents in any issue in any class in which he may be particularly interested.

Glasses for Rainy-day Golf.—President Wilson who is an ardent golfer and also dependent on his eye-glasses is reported as saying that he cannot play the game in the rain because of the accumulation of moisture on his glasses, which leads to the suggestion that specially devised glasses or some treatment of the ordinary lens may solve the problem.

Congress and the Steam Engine.—The Hon. J. Hampton Moore of Pennsylvania, in asking the privilege of inserting in the *Congressional Record* the address of Mrs. Ben Johnson, the wife of a representative from Kentucky, which request was granted by the House, pays a high tribute to Mrs. Johnson's painstaking care in carrying the story from Fitch's birth in South Windsor, Conn., to his death in July, 1798, at Bardstown, Ky. Mrs. Johnson states her purpose as being to secure a suitable marking for Fitch's grave. She quotes numerous letters and other documents on file in the Congressional Library to show a conception and completion of the steamboat by Mr. Fitch, probably 15 or 20 years prior to the initial trip in August, 1807, of Robert Fulton's "Clermont" on the Hudson River. Those having an especial interest in the matter will find the address printed in full in the *Congressional Record* of March 2d, 1915.

Will Your Watch Stand the Test?—We now have in this country an opportunity to secure an official standard of that commodity sometimes compared to money in the often repeated "time is money." The Bureau of Standards, the Official Measurer of the United States, undertakes for a fixed fee ranging from 50 cents to five dollars to report on and certify as to pocket watches. The most elaborate test, known as Class A, involves the running of the watch for 54 days in a series of periods in various positions and at different temperatures. The subject is treated at length in the Bureau of Standards Circular No. 51, which includes treatises on the handling of a watch, its winding and the manner in which it is carried, and will be found of much interest to those who appreciate a timepiece accurate to the highest degree.

.. "Oh, you poor boy!" she cried . . . and kissed him again ..

Not once within his memory had the boy felt the pressure of lips to his own, and this pure kiss of an innocent, childish girl—became a turning point in his life. He had been born blind. To save him the horror of realization his father had taught him since babyhood that all the world, like him, was blind. Light, color, darkness meant nothing to the sightless youth. Then, one day a black eyed, dark haired little iconoclast, her mother soul wrung with pity, pulled down his little world about his ears. Finish this unique and tender story yourself. It is "The Closing of the Circuit," one of many stories—stories that writers like Rex Beach, Booth Tarkington, Robert W. Chambers and others say are some of the best stories ever written by an American author. Today the writer of these stories is old, broken and penniless.

You can help the genius who wrote these stories to come into his own and you can get a new set of his books FREE

FOR years he had been a sailor before the mast, and then when he was 36 years old, came the impulse to write. He never had an education in the regular sense, but he *had* to write. He had within him so strong an impulse that he was forced to write.

He wrote his first story on the washtub of a dreary little room while his wife watched him with discouraged eyes. It was written on the back of circulars which he was to distribute at $1.00 a day.

At once he was famous. His stories began to appear everywhere. He wrote the greatest sea stories that ever have been put on paper—laughing, stirring, tragic—glorious—mean—stories of sailing-vessels—square-riggers in the old days—in the American coastwise service and in strange ports—stories of the steam monsters and stories—human—unique—**of the long steel beasts of the deep—the Dreadnought that crumbles before the slim and deadly t rpedo.** Stories of mutiny—of good fights—of rescue—of shipwreck—stories of brutality—of crimes and shanghai—stories of courage and daring—stories wild as hurricane—sea stories laughing as the sea at peace.

But stories of the sea and battle are not all that he wrote. His fancies play about all conditions of life. Read his love stories. The story of the man whose sweetheart is led astray, who had every feature of his face changed by a surgeon, then shanghaied her betrayer as a sailor on a ship and got a slow and terrible revenge. And there are stories of love and of sweet and tender women.

Yet—*today*—Morgan Robertson is old and poor—for his stories appeared in the days before magazines paid big prices to authors—and though he got much fame—he got very little money. And fame is a poor substitute for beefsteak!

Two big magazines—Metropolitan and McClure's have joined forces to give this writer the reward and recognition due him

What they say of his stories

Indeed, my dear Sir, you are a first-rate seaman—one can see that with half-an-eye.
JOSEPH CONRAD.

His stories are *bully*—his sea is foamy and his men have hair on their chests.
BOOTH TARKINGTON.

The very ocean ought to rise up and bow to Morgan Robertson for his faithful portraiture of itself and its people.
RUPERT HUGHES.

The trail of the sea serpent is over them all.
WILLIAM DEAN HOWELLS.

I know of no American writer more entitled to preservation in volumes. His whole life vibrates with experience and drama.
ROBERT H. DAVIS
of Munsey's.

It will give me great satisfaction to offer you my subscription.
ROBERT W. CHAMBERS.

If you do not tell us soon what happens to Captain Bilke, I will have nervous prostration.
RICHARD HARDING DAVIS.

Morgan Robertson has written some of the best sea stories of our generation.
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Editor Saturday Evening Post.

The magic and thrill of the sea, that bring back to us the day-dreams of boyhood.
FINLEY PETER DUNNE
(*Mr. Dooley.*)

What surprises me so is how the author gets under the skins of the bluejackets and knows how they fee
ADMIRAL "BOB" EVANS.

The ablest writer of sea stories in this country, and sincerely hope that your venture will help him to gain that recognition of his work which is rightfully his.
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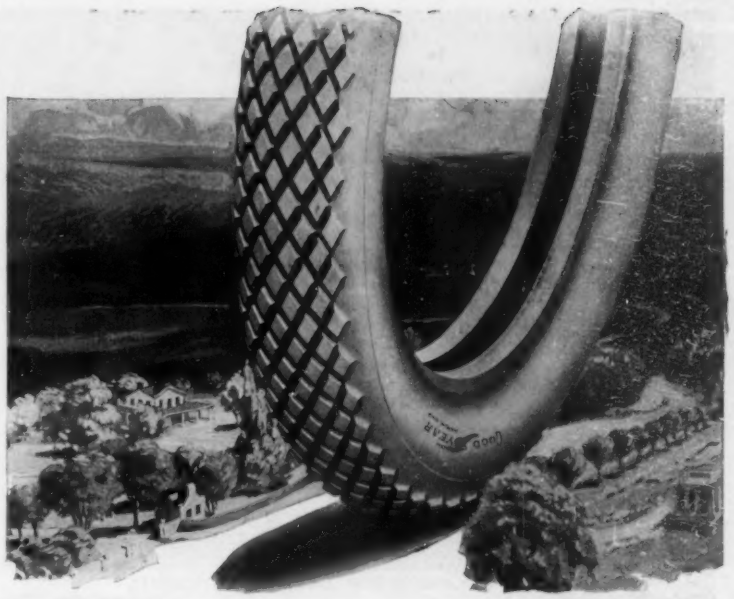

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Goodyear Tires have for years loomed up as the biggest thing in Tiredom. And they are looming up bigger each year. Do you ever wonder why?

Last year we sold about one Goodyear for every car in use. Every week now thousands of new converts adopt them. Don't you think the reasons will apply to you?

They Average Best—That's All

This is because Goodyears are the Fortified Tires.

They are not trouble-proof. They are not exempt from mishap or misuse. But we defend you in the the best way known against each major trouble. And men have proved, by the hundreds of thousands, that these protections mean lowest cost per mile.

All these costly, efficient features are found in Fortified Tires alone. They best combat

Rim Cuts	**Loose Treads**	**Punctures**
Blowouts	**Insecurity**	**Skidding**

One of them—our "On-Air" cure—costs us $450,000 yearly. One requires that 126 braided piano wires be vulcanized into each tire base. One—to combat loose treads—requires the creation of hundreds of large rubber rivets.

And one—our All-Weather tread—requires a tread that's double-thick and tough. It requires deep, sharp, resistless grips, such as no other tire employs.

Goodyear super-quality lies not alone in rubber, fabric and making. It lies also in these five exclusive features, each of which saves countless needless troubles.

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Fortified Against
- **Rim Cuts**—by our No-Rim-Cut feature.
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- **Loose Treads**—by many rubber rivets.
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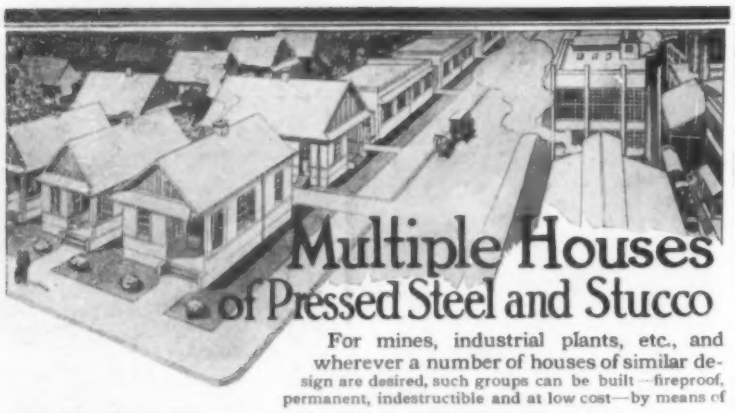

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The Principles of Radio-telephony

(Concluded from page 286.)

distances when it would be suitably modulated by the voice-waves.

Modulation of the wave-producing energy has been one of the most difficult problems of radio-telephony, and is not yet completely satisfactory. For long-distance radio-telephony current in the aerial-wire systems must be as large as 10 or 15 amperes or even more, whereas the microphone transmitters used in ordinary wire work never need to carry more than about one quarter of an ampere. Thus, it became necessary to devise and develop special water-cooled transmitters and microphonic relays for large currents, if full use were to be made of the radio-frequency alternator. This branch of the problem was among the first attacked, and there were produced instruments by the use of which wireless telephony was made a fact over twelve miles during 1906 and over two hundred miles, from Brant Rock, Mass., to Jamaica, N. Y., in 1907. The modulating instrument used in these long distance tests was a special type of differential telephone relay or amplifier, which not only made it possible for the voice to control relatively large amounts of wave energy, but also permitted the interconnection of wire and wireless telephones. By its use a person at his home could speak by wire to another person at some distant point on a second telephone line, an intermediate part of the talking circuit being provided by radio. Thus, the radio telephone can be used to link together existing exchange systems of wire telephones, and subscribers may from their own instruments talk with passengers aboard ships at sea or with others who would ordinarily be isolated because of the lack of through line connection.

Although radio-telephony has been the subject of research and invention by many investigators, and although a large number of devices for production and modulation of radiant electromagnetic waves have been brought forth in the past fourteen years, there has been no departure from the fundamental principles outlined above. The fact that telephony by "wireless" has remained almost purely experimental so long after its inception and first successful practice may be explained not only by a lack of confidence in its present commercial value, but also by the blindness with which many of its practical exponents clung to the use of unreliable instruments of types which should have been discarded long ago.

The Superheated Steam Unit

(Concluded from page 291.)

slide-valve engines for thirty years, is not permitted, nearly all the steam having escaped to the low-pressure receiver and cylinder. Here it expands against the low-pressure piston, escaping to the condenser at the end of the stroke by a set of central ports arranged around the circumference of the cylinder at its center. Of course, the length of cylinder and piston is long enough in comparison to the stroke to allow these central ports to be covered by the piston, except at the end of the stroke. In other words, the thickness of the piston equals the length of the stroke minus the length of the central ports.

This in brief is the construction of a compound uniflow engine as applied to the lokomobile or superheated steam unit. This combination of the two features in one engine is followed by a number of interesting corollaries. Cylinder jacketing now becomes needless, so that the cylinders are brought out in the open instead of being belted with a steam dome or cased in the smoke-box hood. The uniflow distribution of the steam prohibits the use of a superheater between high and low-pressure cylinders, so this is omitted. A radical change is also made in the high-pressure superheater. In order to avoid the long spiral coil of superheater pipe (in large-sized engines exceeding three hundred feet of 3-inch pipe) the superheaters for the uniflow type have two wrought iron headers the length of the smoke box; these headers being joined by many double-

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spiral coils of small pipe in multiple.

These various simplifications enabled the Wolf people to put out a line of large uniflow lokomobiles, the smallest listed being 300 horse-power. The published floor areas of these sizes will be of interest by comparison with ordinary steam plants of the same horse-power, as they represent very fairly the average floor areas of lokomobile plants: For the 300 horse-power, 9 feet 5 inches wide by 22 feet long; 500 horse-power, 11 feet 9 inches wide by 27 feet 9 inches long; 600 horse-power size, 12 feet 9 inches wide by 30 feet 3 inches long; a good deal smaller than our boiler plants alone for the same horse-powers.

The reason is not far to seek. We rate our boilers on 30 pounds of steam evaporated per horse-power-hour; a lokomobile only uses 7 to 10 pounds, hence the much smaller boiler, even including the superheater space. And, incidentally, all the usual boiler losses such as twenty per cent of the coal pile going up the chimney as waste, boiler feed pump charges, radiation, etc., are reduced in a like ratio per horse-power produced.

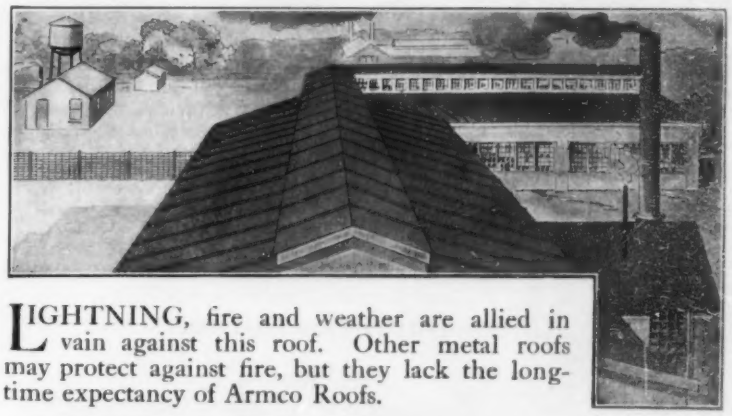
Test 7 is of the American "Buckeye-mobile." This engine is, in effect, a copy of the Wolf tandem compound with double superheat, and both cylinders jacketed in the smoke hood; a few mechanical improvements have been added, such as a trolley rail for running out both superheaters for prompt and easy inspection of the superheaters and the gasket joint and nuts of the forward tube sheet. There is, further, a new piston valve which does not have to have its rings sprung on; and a new type of stuffing box for superheated steam. (Engine shown in Figs. 6 and 9.)

But the main feature of interest to Americans is the fact that this machine is American-built in every feature throughout, with United States Standard nuts, bolts, rivets, shop measurements, tubes, pipes, and pipe fittings. Only those who have had to use a metric-system-built engine in America can appreciate the enormous difficulties of replacing any lost or broken metric fitting in our machine shops. And, from discussions that I had abroad with the German manufacturers, it will be some time before they establish branch factories in this country manufacturing their lokomobiles on American standard measurements. They have enough to do to meet the demand where the metric system holds sway, both the Wolf and Lanz companies building an average of 2,000 lokomobiles each per year without meeting the present European demand.

While these blue-ribbon tests are all very fine, the writer felt that what the American public wanted to know was what the lokomobile could do in daily work in the average mill and industrial plant; what of the 60,000 already built; were they a success, and were the owners ordering more of them? Could the lokomobile be depended upon to show 10 pounds of steam and 1.5 pounds of coal to the brake horse-power in yearly coal account? How about its reliability, its lubrication, and attendance?

While these questions had been partly answered by the lokomobiles I had seen in France and Belgium, a trip to Germany, the home of the lokomobile, would furnish conclusive data, so I arranged for a tour throughout industrial Germany—Berlin, Magdeburg, Dresden, Mannheim, Cologne, Düsseldorf, Duisburg—studying the lokomobile at first hand; its daily coal records, its details of construction, maintenance, operation, every fact of practical importance that could be gleaned.

The task was not as easy as it would be in America. Managers of factories, industrial plants, etc., will not allow a visiting engineer to inspect their power plants to "get a line on" certain engines and boilers, as is cheerfully granted anywhere in America. They will allow a stranger in, however, as a special favor to the engine builder's sales representative, and both the Wolf and Lanz companies were very generous about detailing men to take me to visit various establishments where lokomobiles furnished the motive power. I saw all sizes and types of lokomobiles in every conceivable industry, from elec-



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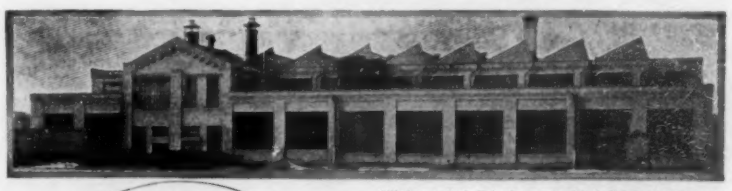

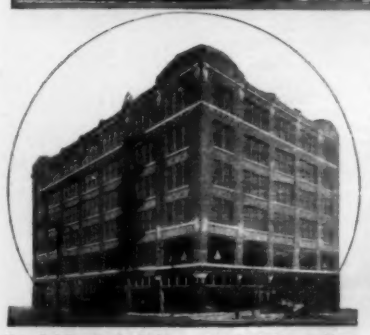

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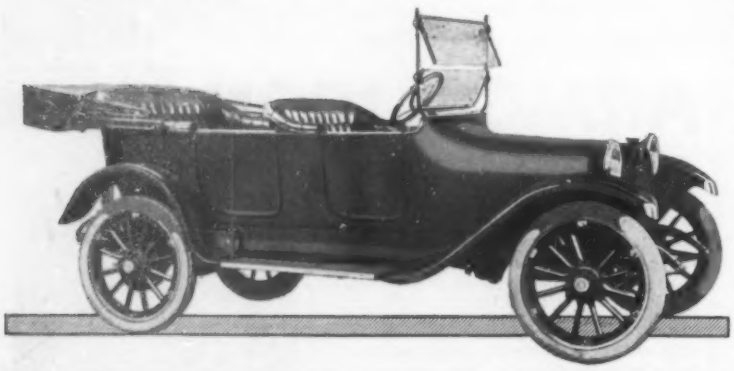

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tric light and power service to candy making. In general the following facts may be accepted as common practice with all of them: The daily coal account in all sizes from 40 to 500 horse-power-hours shows an average of 1.3 pounds of coal per brake horse-power hour, or 2.5 pounds of lignite (5,000 British thermal units). Up to 250 horse-power one man suffices to both fire and run the lokomobile, and, as both engine and boiler *must* be kept clean (for the sake of the engine bearings); both are handsomely finished and decorated, and are kept polished and wiped down, no soot, ash, scale or dirt being tolerated. The class of attendant in charge is about the grade of a licensed engineer that we pay $3.50 per diem for, able to give the engine more intelligent care and the boiler better firing than the average fireman that we employ. As a rule some sort of mechanical stoker was used, and low-grade fuels, such as lignite, peat, straw, sawdust, etc., were easily handled mechanically (also crude oil), the small lokomobile grate being peculiarly adapted to such apparatus. The steam jet for cleaning off superheaters is almost invariably operated once in 24 hours, sometimes twice. Removable furnace and tubes are withdrawn once a year for a thorough cleaning of the shell and tubes from scale. This long time between cleaning is also partly due to the excellent water softening plants in use all over Germany. About an equal quantity of cylinder and machine oil is used per day. The cylinder lubricator oil used is guaranteed at 350 deg. Cent. and some standard form of mechanical pressure feed apparatus supplies it to the engine.

I also visited the works of R. Wolf at Magdeburg and Heinrich Lanz at Mannheim, saw the construction details of lokomobile building and talked with them as to their plans for introducing the lokomobile into America. It is impossible for us to use them as made abroad because of the metric system fittings used throughout. Moreover, it will take us as a nation a good while to realize that here is a good, economical prime-mover, representing millions of horse-power in Europe and her trade dependencies, yet whose qualities are hardly known among our people as yet. The Germans are in no hurry to invade us at present. We have one live engine company making them already, in a large number of sizes, and fitting our standard dynamo ratings. When our engineers do get acquainted with the lokomobile it will take all this company's output, plus what the Germans will be able to send us, specially made for export trade and equipped with United States standard fittings, to supply the demand.

Chestnut Blight Poisoning

THE newspapers, as well as some of the scientific journals, have recently reported several cases of illness and a few deaths supposed to have been due to eating chestnuts from trees affected with the chestnut blight. This subject has been investigated independently by G. P. Clinton, botanist of the Connecticut agricultural experiment station, and by C. D. Marsh, of the United States Department of Agriculture, who reports his results in the *Journal* of the American Medical Association. In both cases the results were substantially negative. Dr. Clinton declares that "there was no evidence that the blight fungus or other fungi were directly connected with the sickness, since experimental feeding of white rats with these fungi failed to produce any injurious effects. Small amounts of pure cultures of the blight were also eaten by the writer without ill effect." He suggests that trees might be so injured by the blight as to produce a greater proportion than usual of nuts not perfectly matured, and that these might possibly contain some self-produced poisonous principle, though this is not considered probable. Prof. Marsh reports to much the same effect. He says: "The symptoms attributed to eating blighted chestnuts were in all cases such as might be produced in some persons by chestnuts from healthy trees."

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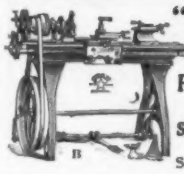

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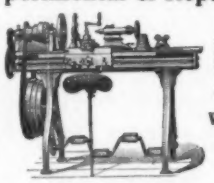

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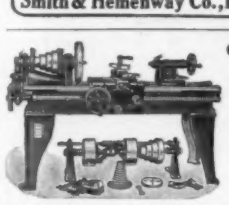

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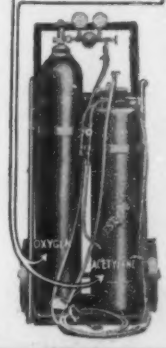

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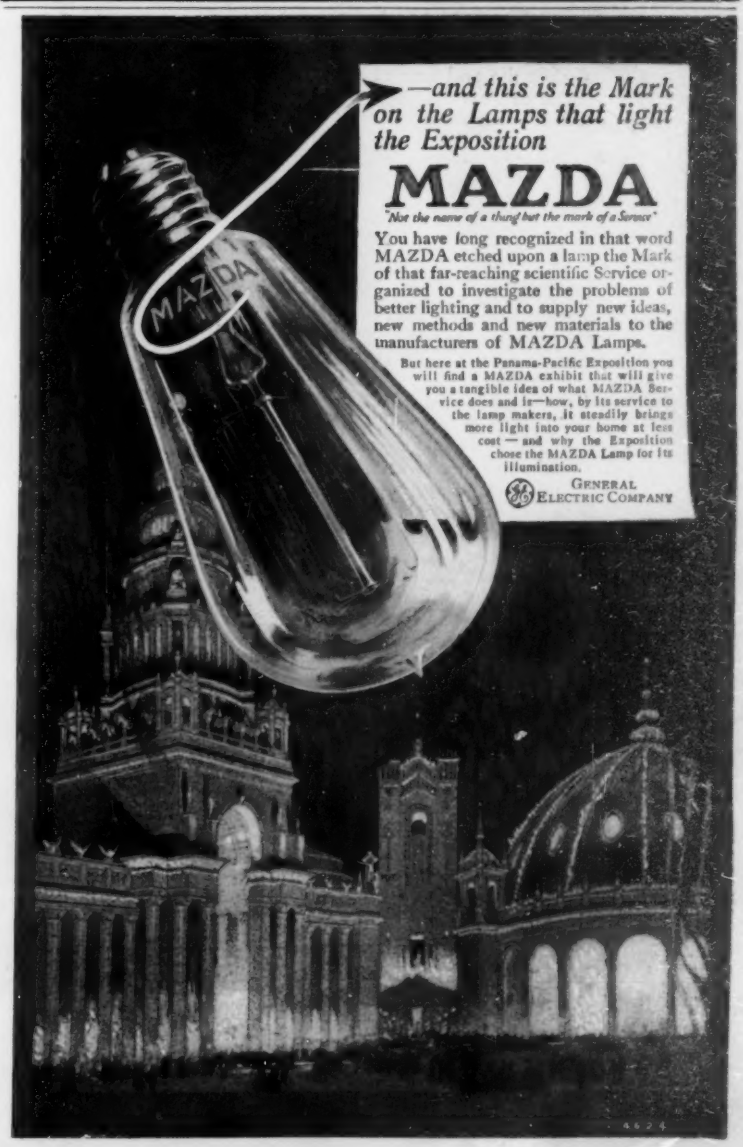

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You have long recognized in that word MAZDA etched upon a lamp the Mark of that far-reaching scientific Service organized to investigate the problems of better lighting and to supply new ideas, new methods and new materials to the manufacturers of MAZDA Lamps.

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The Eight-Cylinder Cadillac

will, we believe, prove itself to be the most constant and the most enduring car this company has ever produced

THE Eight-Cylinder Cadillac is now in the hands of nearly six thousand users.

The motoring world knows that its performances far surpass the most ardent claims that could be expressed in words.

The consensus of expert opinion is, that it is the ultimate in practicability, speed, power, smoothness, flexibility, luxury and ease of operation.

And, in the most essential of all qualities—stability and endurance—there is abundant assurance that it will excel any Cadillac which has preceded it.

We say this, knowing full well that the record of the Cadillac Company for producing cars which endure, year after year, stands unapproached.

We say it with full remembrance of the fact that you can go back one, two, three, four, five, six, seven, eight, nine, ten, eleven, twelve years and find that the Cadillacs then made are still in service.

Recall, if you can, any other cars that can point to service records of half the maximum period cited.

But we are secure in our conclusions for several reasons.

The factors which are primarily responsible for short life and lack of endurance in a motor car, are:

Un-scientific design
Un-suitable material
Un-workmanlike construction
In-accurate workmanship
Poorly fitting parts
Improper lubrication
Vibration

The foregoing being true, then what would more naturally follow, than that scientific design, intelligently selected materials, workmanlike construction, correctly fitting parts, efficient lubrication and absence of vibration, will assure long life and lasting service?

The Eight-Cylinder principle, in itself, appears immensely attractive.

But it offers no promise of unusual smoothness and endurance, unless a correct design be supplemented and supported by the most skillful working out of details.

And its details must in turn be supported by a far higher type of workmanship than is demanded in the more conventional types of engines.

During the past year we have achieved much in the perfecting of materials and their various alloys, making it possible to adopt them with more scientific correctness for the specific duties which they must perform and the strains, stresses and wear which they must withstand.

The reputation of the Cadillac Company for producing the highest type and the most accurate workmanship in a motor car is not disputed, yet the workmanship in the "Eight" surpasses anything ever before achieved by this Company.

Accuracy in workmanship and the proper fit of parts which move in contact with one another, is one vital factor upon which duration of service depends.

In the Cadillac "Eight" there are more than 1000 mechanical operations which are not permitted to deviate to exceed the one-thousandth part of an inch from prescribed limits of measurement. And there are more than 300 other operations in which the limits of permissible variation are held within the half of one one-thousandth of an inch.

When it is remembered that the one-thousandth part of an inch is equal only to one-third to one-half the thickness of a hair from your head, you gain a slight conception of the remarkable accuracy which obtains.

No matter how accurately the moving parts are made to fit, it is absolutely essential that suitable lubricants be introduced to overcome friction, because friction means wear.

The force feed lubricating system used in the Eight-Cylinder Cadillac engine, has proven itself to be the most competent we have ever seen.

The crankshaft practically floats in a thin film of oil under pressure; the oil is efficiently distributed to all cylinders, and the entire engine, as well as the entire car is abundantly provided with lubricating facilities.

Vibration is another factor which is largely responsible for short life and lack of endurance.

But because of its design, its construction, its light reciprocating parts, and its splendid spring suspension, vibration in the Cadillac "Eight" has been reduced practically to the vanishing point.

These arguments, however, mean nothing unless they are supported by evidence.

Experimental cars have for months been driven twenty-four hours a day, under all conditions of weather,—rain and sunshine, in the summer's heat and the winter's cold, over hills and mountains and over the worst roads that could be found.

We were not unmindful of our responsibilities to Cadillac purchasers and to ourselves.

The most priceless asset of the Cadillac Company today is its good name,—the confidence reposed in it by the public.

Upon the maintenance of that confidence there is at stake an investment in plants and equipment which runs into the millions. There is at stake an annual business amounting to more than thirty millions of dollars.

And had the proof fallen short of absolute conclusiveness, the Cadillac Company would never have staked its reputation and its future, because the Cadillac Company has consistently built for permanency above all else.

The experimental cars were not only "tested out." They were grossly abused.

They were subjected to a gruelling such as not one owner in a thousand ever imposes upon his car.

If there were weak points, we wanted to know them.

Yet, after more miles of travel than the average car is driven in five years, the condition of these experimental cars was a revelation, even to us.

Crankshaft and connecting rod bearings required no adjustment, nor were camshaft and bearings perceptibly worn. Pistons and cylinders showed but infinitesimal wear.

Everywhere, from radiator to rear axle, was the evidence of the result of scientific design, intelligent selection of materials, thorough lubrication and Cadillac workmanship.

Everywhere was the evidence that we builded better than we ourselves were aware.

You can learn, in your own way, that the Eight-Cylinder Cadillac neither rides nor drives like any other motor car; that it does more of the things which a motorist wants his car to do; that it performs in ways that you had not thought possible in any car.

And, even having in mind the remarkable stability of its past product, the Cadillac Company has every assurance that its "Eight" will excel all past achievements in constancy and enduring service.

Styles and Prices

Standard Seven passenger car, Five passenger Salon and Roadster, $1975. Landaulet Coupe, $2500. Five passenger Sedan, $2800. Seven passenger Limousine, $3450. Prices F. O. B. Detroit.

Cadillac Motor Car Co. Detroit, Mich.